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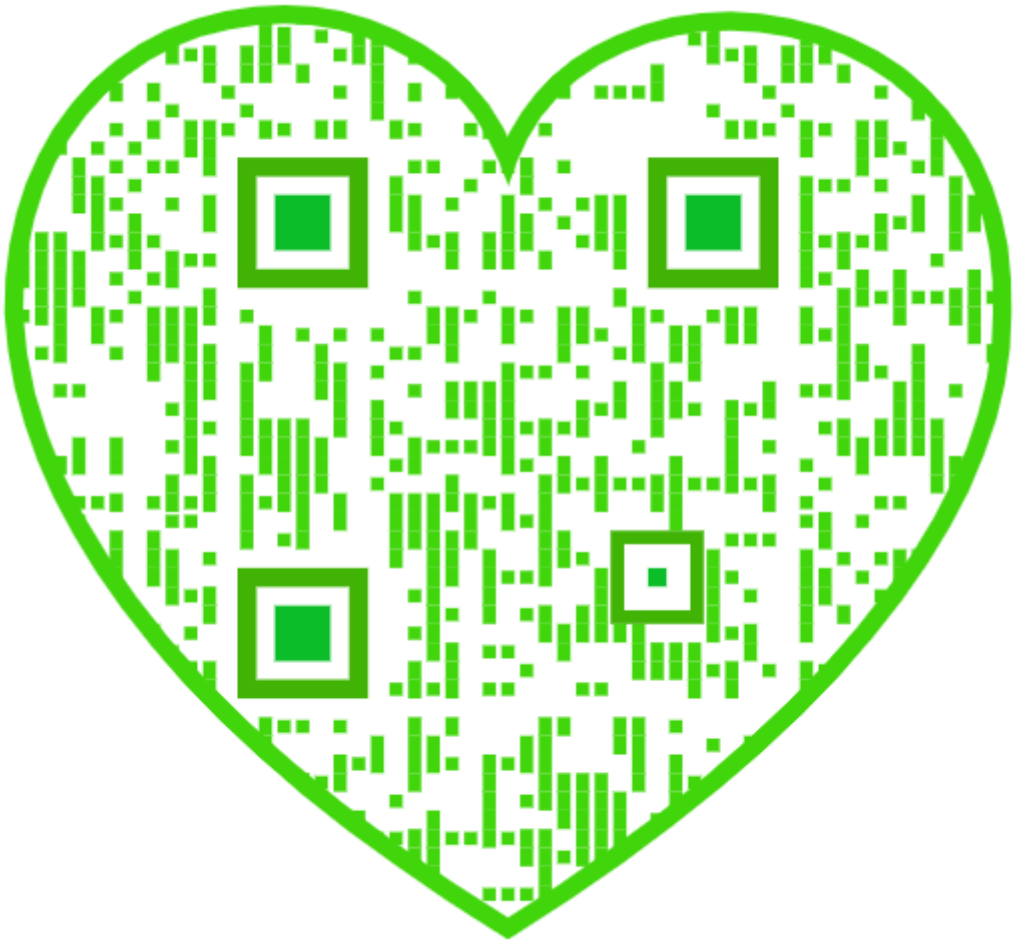

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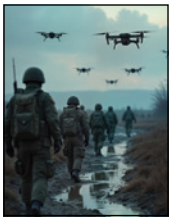
ON THE COVER

Autonomous systems in unmanned aerial vehicles (UAVs) are no longer confined to the realm of theoretical innovation – they're actively reshaping the drone industry. To learn how machine learning, AI and advanced sensor integration are converging to evolve the way UAVs are designed and function, read the feature article on page 18. (Image: Miss Irine/ Adobe Stock)



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INSIDE STORY

High performance materials play a key role in the design and manufacturing of various aerospace and defense applications. Because of the extreme environmental conditions found in aerospace settings, materials used in design and manufacturing need to have properties that can withstand adverse exposure. CS Hyde specializes in high performance polymer films, adhesive tapes, industrial fabrics, and silicone rubbers. In this interview, Arik Barrera, Marketing Manager at CS Hyde Company, discusses the versatility and custom conversion of high-performance materials.

***Aerospace & Defense Technology (A&DT)*: What sectors/ applications of aerospace utilize these types of materials?**

Arik Barrera: CS Hyde works with several sectors of aerospace and defense due to the cross-over of properties associated with the materials we supply. For example, we provide solutions to applications requiring a release film/ fabric for composite molding, dielectric films/tapes for electrical performance or cable/wire wrapping, and high temperature or high strength films or fabrics for impact, wear, and durability. We also supply a full line of high temperature masking tapes used in circuit board soldering, anodizing, plasma flame spray, and powder coating.

A&DT: Can you advise on the challenges of sourcing high-performance materials?

Barrera: CS Hyde specializes in a variety of engineering grade polymer films, specifically skived or extruded polymer films including fluoropolymers, semi-crystalline, and amorphous films. A common challenge with sourcing these types of materials is minimum order quantity either by the pound or in master roll quantities. This can be challenging for design engineers prototyping for an application to source the correct thickness or grade of material. CS Hyde creates sustainable sourcing by offering little to no minimums and ability to order high performance materials in 12" × 12" sheets, by the roll, by the foot, or by the yard in a variety of thicknesses.

A&DT: Beyond sustainable sourcing, are there custom solutions that CS Hyde offers?

Barrera: Yes, CS Hyde specializes in creating conformability through custom conversion. We stock most materials on site, and we offer a full spectrum of converting services. For example, custom width roll slitting and rewinding, automated sheeting, tight tolerance die cutting, as well as prototype parts cut directly from a drawing. One of our unique capabilities is adhesive lamination that consists of laminating a variety of 3M™ adhesives to substrates that commonly do not have adhesive. This can be done on 1 side, or 2 sides of a substrate. An example includes our specialty film tapes including thick gauge PTFE, PEEK Tape, ULTEM PEI and other adhesive backed polymers.

A&DT: What is an example of material solution CS Hyde has provided for the aerospace industry?

Barrera: Outgassing is a critical component in aerospace design. This consists of polymers or organic materials releasing gas or vapor when placed in a vacuum of space. These gases or vapors can be absorbed, dissolved, or frozen, thus creating challenges to maintain a clean area and not contaminate surrounding components. In aerospace applications, especially in space exploration, low outgassing is essential to prevent the contamination of sensitive electronic components, optical systems, and other precision instruments. Gases released from materials can condense on to components, potentially impairing their performance or causing failures. For example, outgassed particles can obstruct optical lenses, affect sensors, or short circuit electronics.

Adhesive tapes create a challenge in aerospace applications because some standard versions exhibit compositions that decompose in vacuum, especially when exposed to high temperature environments. These challenges have enabled us to develop specialized products utilizing materials from premier manufacturers that meet aerospace specifications and are compliant with industry standards. An example solution is our Kapton® film tape featuring a 3M™ low outgassing acrylic adhesive. Polyimide is one of the most frequently used materials in the aerospace industry because of its light weight, thermal stability, chemical resistance, and versatile mechanical properties. Our converting process joins polyimide film with a pressure sensitive adhesive that can be applied on 1 or 2 sides. This can be supplied as a roll, sheet, or die cut into custom shapes or shims.

For more information about CS Hyde, **visit www.cshyde.com**

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CS Hyde specializes in delivering top-tier **adhesive tapes, polymer films, fabrics, and silicone solutions**, all tailored to meet the critical standards of aerospace and defense applications. Beyond supplying premium materials, our advanced converting services ensure precision cutting, laminating, and custom fabrication, providing you with material solutions that can be integrated seamlessly into your aerospace design.

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3D Printing Parts for *Ships, Submarines* and *Underwater Vehicles*

Additive manufacturing has been a game-changer in helping to create parts and equipment for the Department of Defense's (DoD's) industrial base. A naval facility in Washington state has become a leader in implementing additive manufacturing and repair technologies using various processes and materials to quickly create much-needed parts for submarines and ships.

One of the many industrial buildings at the Naval Undersea Warfare Center Division, Keyport, in Washington, is the Manufacturing, Automation, Repair and Integration Networking Area Center, a large development center housing various additive manufacturing systems.

"Imagine one of our [unmanned underwater vehicle] partners coming in here and wanting to modify their vehicle with a mission-optimized propeller or mast," said Bryce Weber, the Technology Manager of the Rapid Prototyping and Fabrication Technology Division. "We can use our industrial additive manufacturing technologies in a sandbox environment to make those modifications, iterate and field them."

Various Navy components, supply organizations and collaborative research and development partners have requested the shop make items ranging from testing devices and training aides to designs that aid production work at naval shipyards and depots for torpedo, UUV and submarine programs. If a ship needs a quick repair — an emergency piece of equipment or an obsolete part, for example — the division's engineers have the tools and talent to develop a solution and produce the necessary parts, helping to return that ship to service faster.

The Technology

Some of the MARINA Center's AM technologies use polymer-based materials to produce components that meet the demanding application requirements of underwater ranges, naval industrial areas and tactical systems. Less critical tools and hardware that are used onboard ships and submarines can be printed using various thermoplastic materials.

Powder bed fusion 3D printers that can print polymers and metals use a heat source to fuse powders into solid objects, layer by layer. The center's metal laser PDF system primarily prints stainless steel and nickel-based alloys to field metal parts. Weber said it's ensuring these parts are compatible with welding and non-destructive testing associated with submarines and ships.

There's also a polymer-based powder bed fusion printer that uses a chemical reaction instead of lasers.

"It's a liquid agent that's jetted down onto the top of the powder surface," Weber said. "Then, infrared light provides the energy, and it cures and builds the polymer chains down into the part. It's very fast, and we can make parts quickly."

Once the machine has finished building, engineers move the pieces to a post-processing station, where they pull the parts from the loose powder, similar to a fossil dig. The leftover power can then be used again.

"That's the nice thing about this technology. You can mix customer parts and orders or parts of wildly different geometries together in the same job and build them together," Weber said.

So, how do they know what they've printed will hold up and be safe? Division technicians work alongside engineering and design agents, system owners and technical authority teams to evaluate the parts based on their material specifications and performance requirements.

"A lot of times, people get very excited about something like 3D printing and want to just use what they have access to rather than the best option," Weber said. "Our talented team has diverse manufacturing experience and is really good at providing the best-fit solution that meets applied engineering require-

ments, whether it be a technology like additive manufacturing or even a conventional one, or a merger of the two."

The team is also leveraging its long-standing expertise in advanced repair technologies, such as laser cladding, which is used for surface restoration repairs on metal parts, and laser ablation, which removes coatings and corrosion from part surfaces.

"In this case, we're even using laser ablation as a new technique to strip the polyurethane off a torpedo component," Weber said.

Easier Access for the Forward-Deployed

The MARINA facility doesn't mass-produce items; it's more of a relief valve to produce maintenance hardware to get assets back to the fleet or maintainer faster.

Moving forward, the center could develop successful AM designs and upload the digital specifications to a repository. Forward-deployed naval vessels and bases that have additive manufacturing maintenance tools can then download the technical data package to make emergency parts. Various programs, such as Naval Sea System Command's AFLOAT additive

A sign highlights what 3D printing equipment and additive manufacturing technology is used at Naval Undersea Warfare Center Division, Keyport's Rapid Prototyping and Fabrication Technology Division. (Image: Air Force Staff Sgt. Eugene Oliver)

Background Image: Ala/Adobe Stock

Pieces of 3D-printed submarine components displayed at the Naval Undersea Warfare Center Division, Keyport's Manufacturing, Automation, Repair and Integration Networking Area Center. (Image: Department of Defense)

An employee at the Naval Undersea Warfare Center Division, Keyport in Washington points to a metal submarine part printed by additive manufacturing technology. (Image: Department of Defense)

Bryce Weber, the technology manager of the Rapid Prototyping and Fabrication Technology Division at the Naval Undersea Warfare Center Division, Keyport, explains how a motor generator system currently under development can help with future submarine repairs. (Image: Department of Defense)

manufacturing program, are working to more widely deploy 3D printing equipment onto surface ships or to shore-based facilities to create what Weber described as a "shop in a box."

Since 2002, Keyport has produced tens of thousands of additive-manufacturing parts for a wide range of applications. The division works closely with the Naval Systems Engineering and Logistics Directorate's Technology Office on specifications for any parts it makes.

Weber's team also develops robotics solutions that can repair submarine equipment and parts at the point of need. This allows submarine crews and maintenance personnel to do repairs themselves, cutting weeks off critical path maintenance.

"We are filling a niche of designing, integrating, deploying and supporting custom repair systems that don't have strong profit models for industry but have major readiness implications for the fleet," Weber said, explaining that most industries are interested in mass manufacturing items. "This work is saving a huge amount of time and funding."

Teamwork: Helping Innovate From Within

The MARINA center also houses the Keyport Innovation Center, a collaborative space where anyone at NUWC Keyport or with DoD credentials can learn new additive manufacturing skills and create prototypes using commercial, off-the-shelf technology. The KIC is the place to go for anyone looking to quickly turn a concept into reality.

"We're trying to break down the silos between departments because a lot of departments are doing similar things, but nobody talks to each other," said Warren Penny, a computer engineer who helps run the KIC, which was set up about two years ago and runs on Naval Innovative Science and Engineering funding.

Keyport's engineers can test out designs using several resources, helping to reduce costs and increase the speed of prototyping for direct-funded work. The KIC's popularity has led to many repeat customers.

"We do 3D scanning, 3D modeling and 3D printing," said Army Sgt. Justin Jones, who works at the KIC as part of the Personnel Force Innovation initia-

tive. “Basically, you can go through the full steps of reverse engineering a component and remanufacturing.”

Penny explained how DoD benefits from the process using circuit board obsolescence as an example.

“The Navy and other armed forces have a really big problem with obsolescence. A lot of our stuff is really old,” he said. “Unfortunately, the companies that have produced our circuit boards either don’t make them anymore or have gone out of business, so we can’t buy more parts.”

However, they can use a new Scan CAD system to take high-resolution images of the layers of those circuit boards and pair them with other data to build a file to reverse engineer the board. Penny said it saves both money and time.

“It’s the same board — we’re just learning how to build it,” he said. Soldering equipment for designing and prototyping circuit boards is available, too, he added.

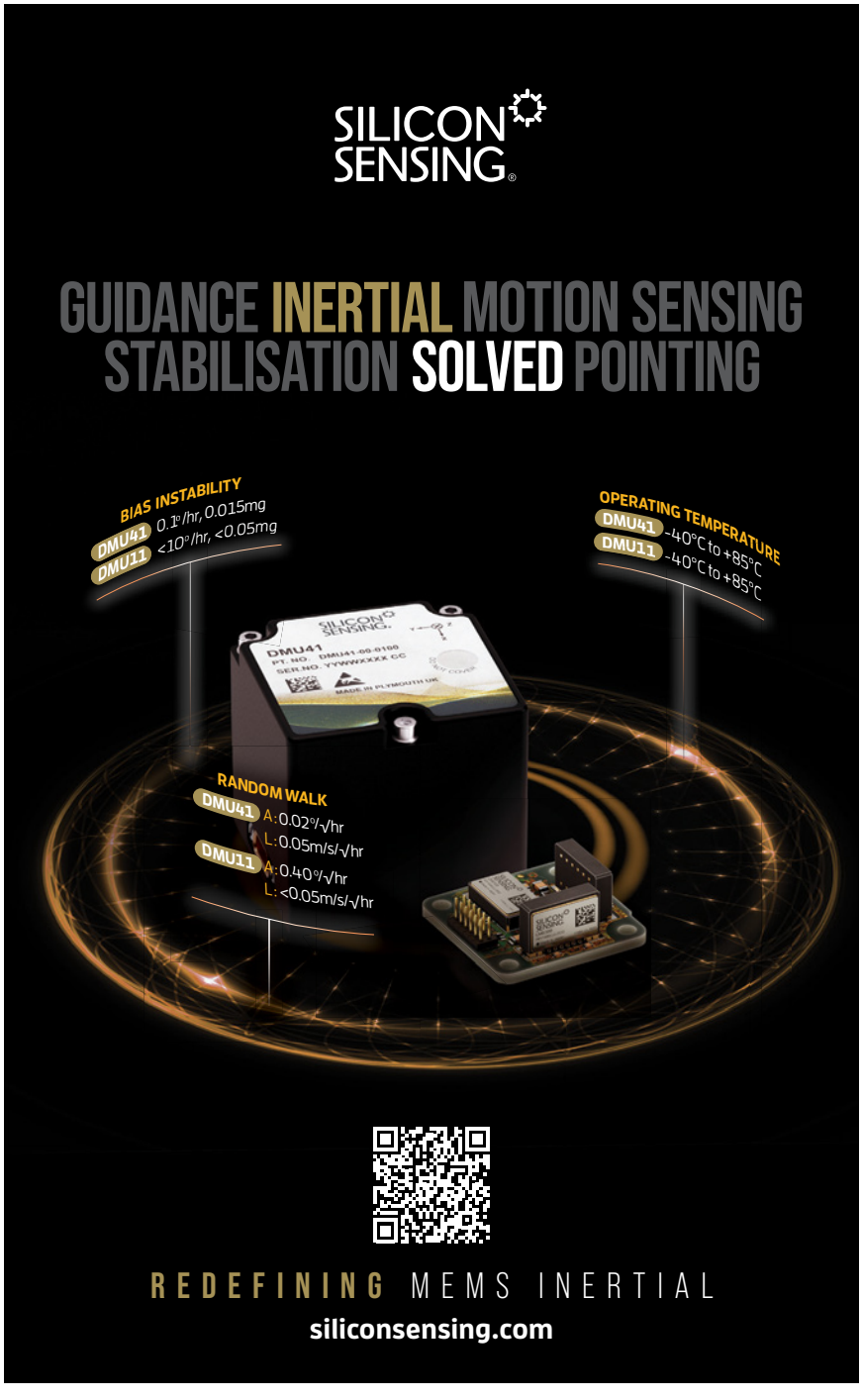
The KIC also has modeling and simulation computers, as well as training classes for engineering software tools such as MATLAB, Solid Edge, SolidWorks and Ansys. One example of their use came when engineers had concerns about area earthquake activity. Using those computers, Keyport’s Test and Evaluation Department collaborated with Puget Sound Naval Shipyard to model seismic anomaly activity to determine what kind of damage a large earthquake would do to their assets, Penny said.

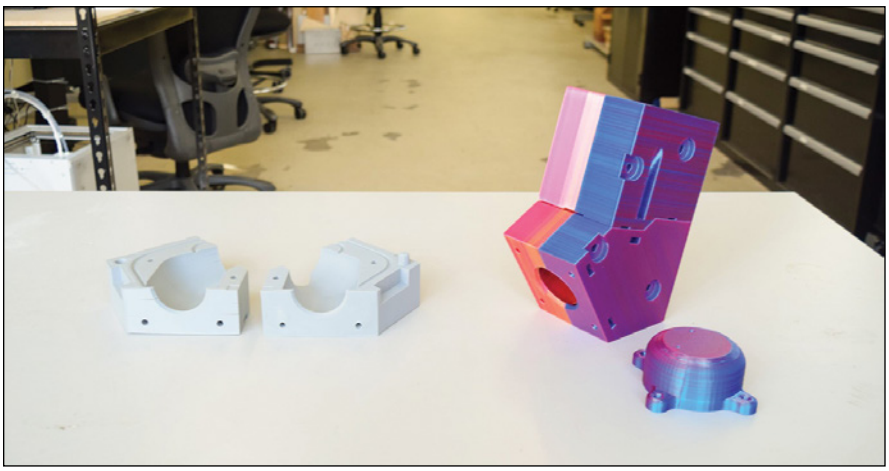
The KIC’s 3D printing area includes seven fused deposition modeling printers, which Penny described as “like a glorified hot glue gun.”

“It takes rolls of [polylactic acid] plastic ... and we feed it a code, and it’ll just run layer by layer. It’ll draw it out with the plastic, the first layer, and then it’ll build it up,” he explained. There’s also a stereolithography, or SLA, printer that uses UV-cured liquid resin, which makes much thinner layer lines and creates parts with extremely high detail.

Penny said workers from the Undersea Systems and Sustainment Engineering Department, known as Code 40, came in looking for a way to repair tow-behind cables. Usually, when the cables decayed or broke, replacements cost between $15,000 and $20,000 each. The KIC helped them develop a 3D-printed plastic mold to repair them instead.

“They were able to patch together the wiring and then put it in the mold and inject an epoxy resin into it. That goes through a curing process, and it worked out perfectly. It costs them maybe $2,500 [to] $5,000,” Penny said. “Their costs savings is astronomical. That’s one of the things that we like to showcase — that we’re helping the Navy save money.”





A test print of a 3D-printed cable repair mold recently developed by a mechanical engineer sits on a table at Naval Undersea Warfare Center Division, Keyport, Jan. 16, 2024. The mold was made using resources available at the Keyport Innovation Center, a collaborative space where individuals from across the command can partner, share knowledge and foster a culture of innovation and growth. (Image: Jacob Snow, Navy)

The KIC also has a 60-watt fiber Fusion Galvo laser engraver for metal that can cut through steel. Jones said it's used for nameplate labeling, colorizing and embedding data via barcodes and QR codes onto equipment, such as torpedo shells. A similar Gantry laser can cut and engrave various other materials in a larger build space.

Penny explained one success story in which someone from Code 40 used the Epilog Fusion M2Co2 Gantry laser to cut gaskets that originally had to be cut by hand with scissors — a long process with a 60-70 percent success rate.

"[We] worked with one of their engineers and brought them in here, and they digitized the template and were able to cut them out in about five to 10 seconds, with 100 percent accuracy every time," Penny said.

Since then, that department has purchased its own laser engraver for future use.

"What we do here reduces so much costs," Jones said.

This article was written by Katie Lange, a Writer for the Department of Defense (Washington D.C.). **For more information, visit www.defense.gov.**

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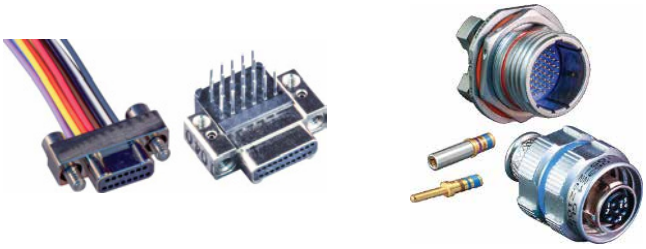

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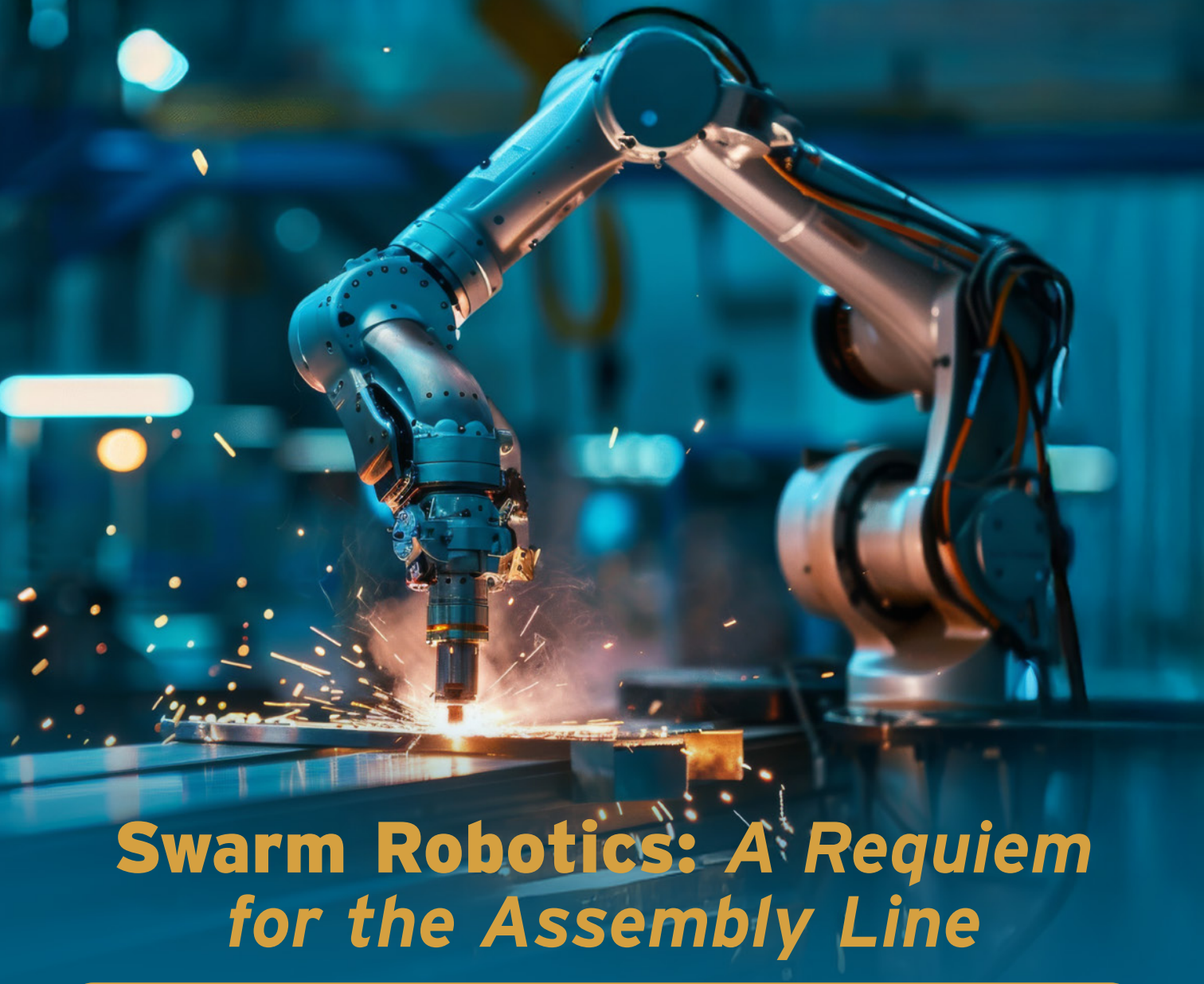

Swarm Robotics: *A Requiem for the Assembly Line*

Aircraft manufacturing is on the cusp of its most profound transformation since the dawn of powered flight. The assembly line — a staple of industrial production for over a century — is about to be replaced by a far more efficient and cost-effective alternative: Swarm Robotics. It's an Artificial Intelligence (AI)-driven manufacturing system where autonomous robots work with a common "consciousness" guided by Generative Artificial Intelligence (GenAI) to self-program a large-scale manufacturing process.

The assembly line system, invented by Ransom Olds in 1901 and refined by Henry Ford in 1913 to make his cars, has dominated manufacturing for over a century. Swarm Robotics will replace it, transforming the way large, complex structures such as airplanes and aerospace assets are built. By leveraging AI-driven, self-coordinating robots, it will enable faster, lower-cost production while delivering higher precision and enhanced safety.

Some Important Definitions

Programming robots using conventional coding, no matter how sophisticated, is not AI. It is simply computer programming of robotic arms and machines. It is merely advanced automation or "Level 1" programming.

The next "rung" up is true AI, or what we'll label "Level 2" robotic programming that enables machines to process data, make predictions, and assist in decision-making. When the programming is used to animate a machine, it uses a system developed to provide the machine with human-level general intelligence capable of understanding, learning, and solving problems in a particular segment of human activity. This form of automation is widely used today in quality control, logistics, and predictive maintenance, but remains reactive – in effect, using high-speed computer processing and data analytics to perform repetitive tasks and provide predictions.

By contrast, GenAI, or "Level 3" robotic programming, enables robots to train themselves based on vast amounts of data, recognizing patterns, optimizing processes, and autonomously improving their own performance, without direct human programming. This shift from human-defined algorithms to self-evolving AI will ultimately make Swarm Robotics capable of unprecedented levels of precision, adaptability, and efficiency.

Most people are familiar with ChatGPT, which uses GenAI models that pull data from the internet in vast amounts to generate high-quality human-like text, images, and other content in response to a user's request. Swarm Robotics will

Image: Pat J./Adobe Stock

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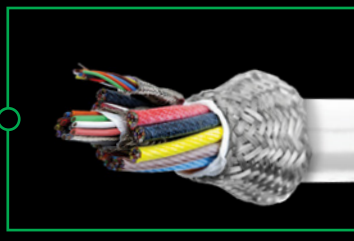
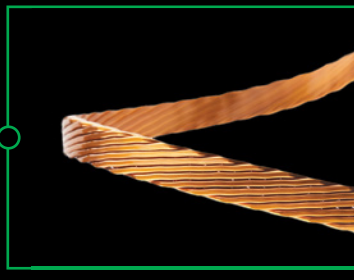
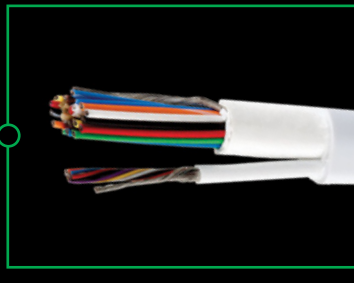
CUSTOM CABLE FROM COAST TO COAST







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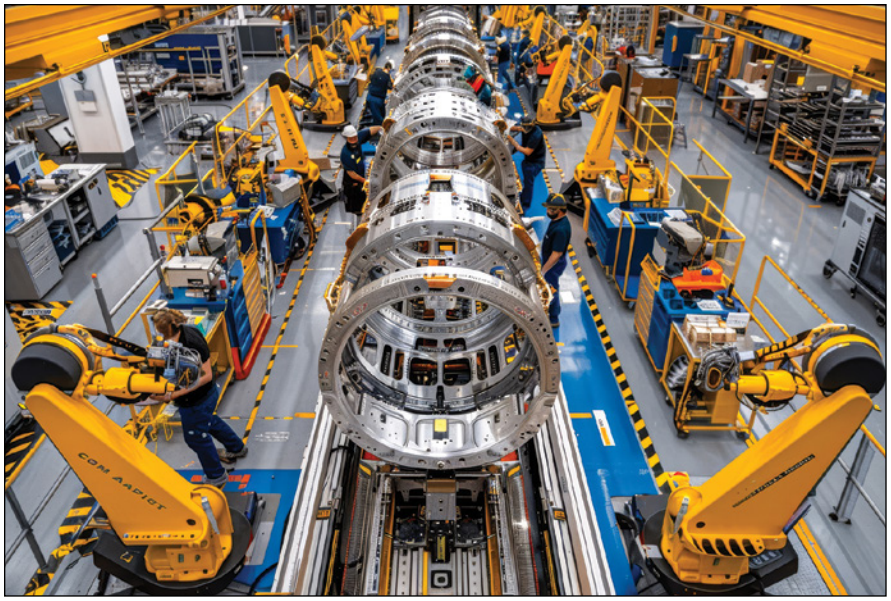
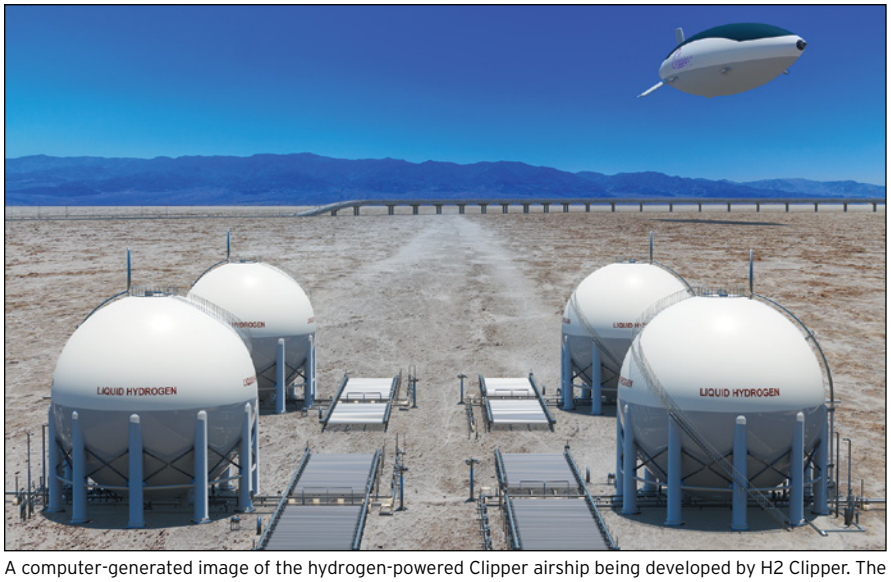


H2 Clipper, the California-based startup developing the hydrogen-powered Clipper airship, believes its patented Swarm Robotics concept could significantly change the concept of an assembly line in aerospace manufacturing. (Image: Pixels/Adobe Stock)



A computer-generated image of the hydrogen-powered Clipper airship being developed by H2 Clipper. The company has been developing Clipper for several years as an airship capable of transporting fuel cell grade hydrogen. In addition to its cargo, hydrogen is also Clipper's source of propulsion and lift. The company wants to use the concept of Swarm Robotics to assemble Clipper and other aircraft. (Image: H2 Clipper)

apply the same principle to robotic manufacturing, allowing autonomous robots to coordinate action, and adapt their processes in real-time.

"Swarm Robotics," as the term is used in H2Clipper's recently granted U.S. patent, will use GenAI to create a self-learning common mind among two or more interconnected autonomous or floor mounted robots that are able to interact with each other and react to the environment autonomously. These robot swarms will be used to manufacture large physical structures like airplanes and spacecraft without moving the structure during production with minimal human supervision.

This will significantly change the way assembly line functions.

The speed and accuracy obtained from using Swarm Robots operating 24 hours per day will save massive amounts of cost and time. It will also permit a level of accuracy in the fabrication of existing aircraft designs by eliminating human error caused by fatigue, distraction in the assembly process, carelessness (e.g., omitting to properly bolt an aircraft door), or failure to adhere strictly to fabrication designs.

Viewed in the foregoing context, the advent of Swarm Robotics represents an even greater transformation in manufacturing technology than pre-industrial England experienced from the substitution of machines for human labor during the Industrial Revolution.

Understanding the Development of Swarm Robotics

The idea of swarm intelligence is not new. Researchers in AI, robotics, and even military strategy have explored how self-organizing systems — like ant colonies, schools of fish, and flocks of birds — solve complex problems without centralized control. The concept has been applied to software algorithms, drone coordination, and even logistics planning. What had never been done was to apply these principles to the construction of large-scale structures. That was the missing piece. That was the insight that led to the birth of Swarm Robotics in the patents for aircraft, spacecraft, and airship manufacturing.

In H2 Clipper's patents, a hierarchical progression of programming required to achieve full GenAI capability is articulated, encompassing all three phases of development. As described previously, Level 1 focuses on programming multiple ambulatory and floor mounted robots to operate in unison, constructing the aircraft from the ground up without requiring any movement of the structure until it is fully assembled. This foundational stage establishes coordinated, automated assembly, setting the groundwork for more advanced AI-driven operations. Dassault 3DS has plans to provide this "Level 1" robotic programming in partnership with H2 Clipper.

"Level 2" is where advanced programming transitions from conventional automation to adaptive AI-driven robotics — where robots not only execute tasks but also self-regulate and coordinate their functions dynamically. At this stage, the system moves beyond pre-programmed repetition and introduces machine-learning algorithms that enable real-time collaboration and autonomous problem-solving.

Unlike automotive manufacturing, the fabrication of large aerospace assets requires a higher degree of autonomous coordination, precision, and adaptability. As described in our patent, Swarm Robotics at Level 2 leverages existing innovations while extending them into a domain where traditional factory footprints and conventional automation techniques are no longer viable.

Achieving Level 3 robotic programming will naturally evolve. To enable this, the patent explains that the Level 2 software would be taught the proprietary process. It would be educated on how parameters for the software had been set to be able to "understand" what it was taught to do and how; and then instruct it to begin teaching itself. That is the point where Level 3 or GenAI begins.

Humans, with our limited processing capability, will not be able to define the myriad of relationships that have to exist from second to second if we intend for the robots to act with one mind as ants do. Creating a "Smart" mind is so complex an undertaking that we require machines capable of self-learning software generation. In effect, we have to create the programming equivalent of millions and millions of synapses firing simultaneously every microsecond with a variety and speed no human could program. GenAI can and will — and it won't stop with aircraft manufacturing. The robotic manufacturing approach described in the patent will ultimately be utilized for an endless array of large structure manufacturing, and eventually for small scale as well.

The Future of Swarm Robotics in Aeronautical Assembly

There are innumerable commercial, environmental, and safety advantages for fabricating existing aircraft utilizing Swarm Robotics. Beyond those near-term manufacturing and financial advantages, it is hard to imagine that Swarm Robotics won't heavily influence future aircraft, autonomous drone, electric short-range passenger vehicles (e.g. sky taxis), military and spacecraft design. History tells us that new production techniques give way to new human systems. This is true from the Bronze Age, when humans learned the metallurgical process for combining different metals to create new weapons and agricultural tools; to the invention of the process for fabricating all the modern technological marvels from microchips.

Knowing that we can fabricate, and service, aircraft using Swarm Robotics will not only unleash the age of lighter-than-air aircraft that will revolutionize air freight and air passenger service for generations to come, it will also provide us with a faster, significantly more economical way to construct other aircraft and aerospace assets.

It is a truth as old as civilization that faster, less expensive, safer, and more reliable manufacturing methods always advance human

H2 Clipper wants to increase the use of robotics for various processes involved in aircraft design and manufacturing. (Image: Premruthai/Adobe Stock)

civilization in a myriad of ways. An axiom to this observation is that the greater the technological advance, the more rapid and widespread the beneficial effects.

The assembly line was one of the most consequential innovations in history. Just like horses still pull wagons, but no longer drive commerce, the assembly line production approach may persist in some form, but it will no longer define the future of aerospace manufacturing.

Aerospace could become the first industry that will likely experience Swarm Robotics as the alternative to assembly line manufacturing. Other industries that manufacture complex or physically large objects will soon follow. The adoption cycle for new technologies is getting shorter and more robust every year.

Undoubtedly, the risk is greatest for aircraft manufacturers who intentionally retain manufacturing methods born of the early 1900s. Embracing technological innovation, such as Swarm Robotics, is the path to the future.

This article was written by Rinaldo S. Brutoco, President, World Business Academy, CEO H2 Clipper Inc. (Santa Barbara, CA). **For more information, visit www.h2clipper.com.**

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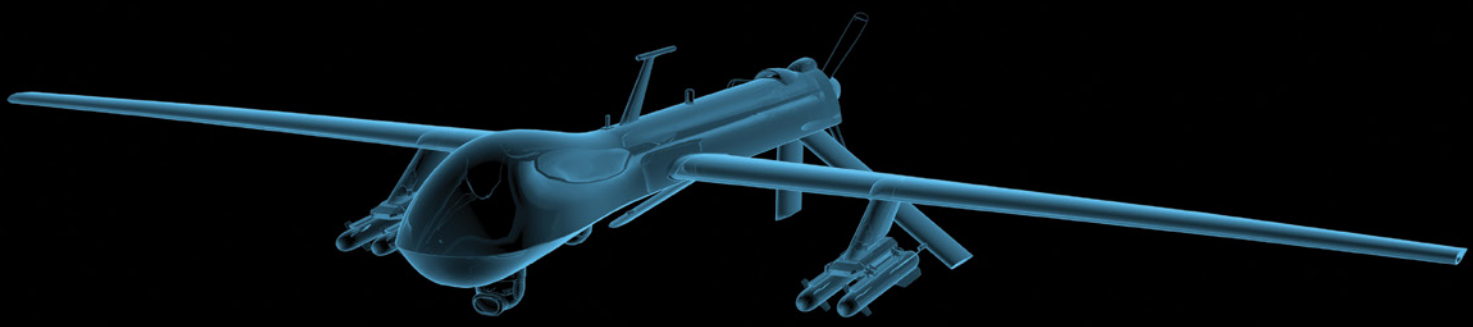


The Evolution of Autonomous Systems in UAV Technology: *Challenges, Opportunities, and the Next Frontier*

Autonomous systems in unmanned aerial vehicles (UAVs) are no longer confined to the realm of theoretical innovation — they're actively reshaping the drone industry.

As machine learning, artificial intelligence (AI), and advanced sensor integration converge, UAVs are rapidly evolving to achieve true autonomy, unlocking new frontiers in design and functionality. This evolution is driving seismic shifts in UAV engineering, presenting both a formidable challenge and a prime opportunity for designers and manufacturers to redefine industry standards.

The push for complete autonomy is expanding the very definition of what UAVs can do, demanding groundbreaking advancements in every aspect of design, from flight systems to mission flexibility.

So let's talk about it: what's happening in 2025?

Advancement of Autonomous UAVs: A Technical Overview

The foundation of autonomous UAVs lies in their ability to make decisions and execute maneuvers independently of human control.

This autonomy is powered by a combination of high-precision sensors, AI-driven algorithms, and real-time data processing capabilities. Over the years, UAV systems have evolved from basic remote-controlled devices into highly sophisticated platforms capable of performing complex tasks in dynamic environments.

In the early stages, UAVs required a significant amount of human oversight, with operators often controlling the systems in near-real-time. However, with advancements in AI, particularly reinforcement learning and deep neural networks, UAVs are increasingly able to process data, make decisions, and adapt to new situations with minimal external input.

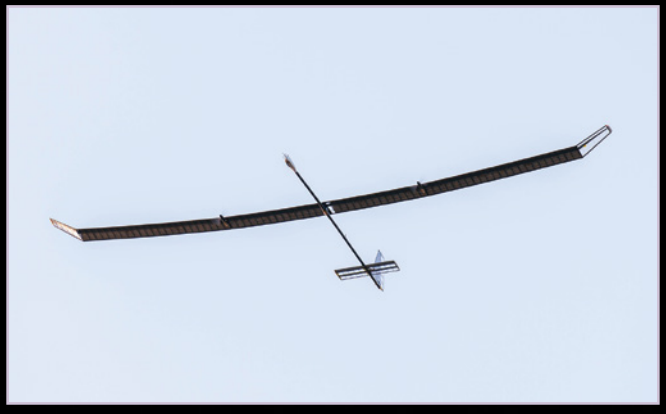
These systems continuously refine their models based on environmental feedback, which enhances mission effectiveness and reduces the risk of failure in challenging or hostile conditions.

Prominent Challenges and Opportunities for Fully Autonomous UAVs

The journey toward fully autonomous UAV systems is far from straightforward. Several critical challenges need to be overcome, including regulatory hurdles, technological limitations, and integration with existing air traffic management systems.

The safe integration of UAVs into civilian airspace remains one of the most significant challenges.

Unlike manned aircraft, UAVs rely on algorithmic navigation, which creates complexities in collision avoidance and air traffic management, especially in congested airspaces.



Swift's solar powered high altitude pseudo satellite (HAPS) SULE aircraft. (Image: Swift Engineering)

Background Image: JustContributor/Adobe Stock

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As such, the UAS Integration Office is responsible for leading the FAA's efforts to safely integrate autonomous drones into the U.S. National Airspace System. Technical innovations, such as detect-and-avoid systems and collaborative air traffic control systems, are being actively developed to address the most pressing concerns.

To operate autonomously in complex environments, UAVs need to process a large volume of data in real-time. This requires advanced sensor fusion, where data from multiple sources (e.g., radar, LiDAR, infrared) is integrated to create a comprehensive understanding of the UAV's surroundings.

The decision-making algorithms must then determine the optimal course of action, often in uncertain or rapidly changing conditions.

The demand for longer flight times and larger payload capacities presents a significant engineering challenge. UAVs must maintain their energy efficiency while integrating heavier, more powerful sensors and computing systems.

Battery technology and alternative power sources, like hybrid propulsion systems, are areas of active research that are key to achieving greater autonomy.

As UAVs become more autonomous, they also become more vulnerable to cyber threats. Just look at the increase in malicious cyber activity directed at drones in both the Russia-Ukraine war and the Israel-Hamas confrontation.

From cyber vulnerabilities and hijackings to the weaponization of UAVs, many threats have been observed in UAV technologies. Securing communication channels and confirming system integrity is critical — particularly for UAVs operating in sensitive environments, such as defense, healthcare, and logistics.

Despite these various challenges, the opportunities presented by autonomous UAVs are vast. Industries ranging from agriculture to logistics, search and rescue, and defense are poised to benefit from these technological advancements.

Real-World Applications and Case Studies from Swift Engineering's Portfolio Swift Engineering has been at the forefront of developing and deploying autonomous UAV systems across various sectors.

In the defense sector, Swift Engineering has contributed to the development of UAVs that can autonomously perform reconnaissance missions, reducing the risk to human personnel and improving operational efficiency.

In 2020, the company's high altitude long endurance (HALE) unmanned aerial system completed its maiden voyage, validating its configuration for high-altitude continuous surveillance systems. These systems integrate advanced sensors and autonomous navigation capabilities to operate in hostile environments, providing critical intelligence with minimal human oversight.

Another area where Swift Engineering's expertise has been leveraged is in search and rescue missions. Swift has developed Marine Sensing Solutions that integrate advanced sensing, data collection, and real-time analysis to revolutionize marine operations.

These are designed to support industries such as oceanographic research, environmental monitoring, and defense by providing high-quality, real-time data from remote or hazardous marine environments. Additionally, Swift's technology enables autonomous vessels to collect valuable insights while reducing risks, operational costs, and the need for human intervention.

During a demonstration in November 2024, Swift's HAPS aircraft reached an altitude of 56,000 feet in a flight that lasted more than 24 hours. (Image: Swift Engineering)

The Next Wave of Innovation in UAV Design

Looking ahead, the next wave of innovation in UAV design will be driven by advancements in artificial intelligence, machine learning, and hardware miniaturization.

Some areas to watch include:

AI-Powered Autonomous Decision-Making

UAVs are increasingly leveraging deep learning to make real-time decisions based on situational context, including environmental factors and mission objectives.

A 2025 study "Deep Reinforcement Learning based Autonomous Decision-Making for Cooperative UAVs: A Search and Rescue Real World Application" written by several university researchers in the UK proposes a framework utilizing Deep Reinforcement Learning (DRL) for guidance, navigation, and task distribution among multi-drone systems operating in GNSS-denied indoor settings.

As AI technology evolves, UAVs will gain the power to seamlessly navigate unpredictable environments. This will likely transform the way they execute high-stakes missions like search and rescue, pushing the boundaries of autonomous operations to new, unprecedented levels.

Advanced Sensor Technologies

Improvements in sensor resolution and integration will allow UAVs to operate in even more complex conditions, such as inclement weather, low light, and GPS-denied environments.

For example, radar and LiDAR systems are becoming more compact and accu-

rate, allowing for better detection and avoidance of obstacles. The integration of advanced sensor fusion algorithms and real-time AI processing significantly bolsters the detection, classification, and countering of UAV threats in increasingly complex environments.

Collaborative UAV Networks

The future of UAVs could involve fleets of autonomous vehicles working together as part of a coordinated network. These collaborative systems would share data in real time, allowing UAVs to adapt and complete tasks more efficiently. Such systems would have applications in logistics, disaster response, and large-scale infrastructure inspection.

A Comprehensive Review of UAV-UGV Collaboration published in the Journal of Sensor and Actuator Networks in 2024 dubbed this type of integration as a "significant leap forward in the field of robotics, with implications for a wide range of industries." This review also highlighted the progress already made, along with advancements in communication frameworks and coordination strategies that underpin these efforts.

Autonomous Logistics and Last-Mile Delivery

As UAV technology advances, we may see fully autonomous systems capable of delivering goods and medical supplies in urban environments. These systems would integrate seamlessly with existing infrastructure, reducing human intervention and optimizing supply chains.

For instance, Ukrainian forces have integrated AI-driven solutions into their military operations, enhancing drone strike accuracy and reducing reliance on manual piloting, even in areas protected by electronic warfare.

These developments highlight the rapid evolution of UAV technologies, offering futuristic capabilities across various sectors, including defense, logistics, and emergency response.

The future of autonomous UAV technology is a fusion of cutting-edge engineering and real-world application. As the industry tackles the complexities of airspace integration, sensor advancements, and cybersecurity, the potential for fully autonomous UAVs to redefine entire sectors is unparalleled.

An image of Swift Engineering's group 1 full electric long-range unmanned aerial system (UAS). (Image: Swift Engineering)

The sky is no longer the limit — it's just the beginning of a new era in autonomous UAV technology.

This article was written by Hamed Khalkhali, President, Swift Engineering, Inc. (San Clemente, CA). **For more information, visit www.swiftengineering.com.**

Reverse Engineering the Security Risks of the AeroScope Drone Detection Module

Assessing the security risks of the AeroScope upgrade module, which supports foreign government-specified encryption of the data signal.

Da Jiang Innovations (DJI)'s AeroScope drone detection platform has proven to be an effective security tool for military and law enforcement. It identifies and tracks drones in real time, providing AeroScope users with information like flight status, path and pilot location for drones up to 50 kilometers away. This data stream enables users to make fast and informed responses as soon as possible, mitigating the potentially harmful effects of consumer drones in and around public spaces, government facilities, infrastructure and other no-fly zones.

Yet despite its efficacy as a public safety tool, AeroScope now comes with major security risks. Despite discontinuing the system in 2022, in 2024 — after only a few months of notice — DJI introduced a new encryption mechanism to their AeroScope system, along with a hardware upgrade in the form of a USB device, or dongle. Unmitigated, this update significantly impacts the AeroScope's ability to reliably process data at a large scale and introduces further vulnerabilities to the system.

Encryption enables foreign governments to potentially conceal drones based on geographic location and serial number. It also renders DJI drones invisible to non-upgraded AeroScopes, undermining the effectiveness of counter-small unmanned aircraft systems (C-sUAS) and creating serious blind spots in U.S. airspace surveillance. Finally, non-DJI radio frequency (RF) systems are incompatible with the dongles, rendering them useless in detecting encrypted DJI aircraft.

DJI's AeroScope drone detection platform, pictured here, is capable of identifying UAS communication links, flight paths and other information in real-time. (Image: DJI)

In short, the very system you bought for safety is no longer safe, making it necessary to develop risk mitigation strategies for DJI products. For example, Edgesource Corporation has developed the Windtalker™ passive RF sensor that incorporates AeroScope but firewalls it from external networks, preventing AeroScope from phoning home to the DJI servers.

Yet questions remain. Even if the dongle's primary function is to enable decryption of the newly encrypted signals from DJI drones, what else does the upgrade module do? What unknown code or commands do the modules contain? What are the risks of upgrading — or not upgrading — the sensors?

Mounting Global Tensions: Threats to National Security

This is not the first time DJI has faced scrutiny as a security risk. The company manufactures drones, gimbals, cameras and other products that can — and are — used for military purposes. Recognizing these threats, the U.S. Department of Defense (DoD) began restricting commercial off-the-shelf (COTS) drones in 2018. In 2021, a presidential executive order required extensive reviews of certain government-made drones in U.S. government fleets. And in 2020, the U.S. Department of Commerce added DJI to its list of entities that act contrary to U.S. national security and foreign policy interests.

Yet despite these and other concerns, DJI has dominated the small drone market, accounting for as much as 80 percent of the world's commercial small drone sales. Even while recognizing the inherent security risks in DJI products, we are faced with the reality that there is no domestic alternative that manufactures products and solutions of comparable technological advancement.

The Purpose of the Dongle: Benign or Malicious?

The new upgrade modules support the addition of encryption to DJI's previously unencrypted AeroScope data signal. Specifically, its function is to validate the encryption via communication with DJI servers, which return communica-

tion back to the AeroScope for the code to decrypt the data signal.

Yet despite the dongle's seemingly benign purpose — to "support the AeroScope system update and ensure that AeroScope is compatible with future DJI aircraft products" — it raises several security concerns. For example, the back-and-forth communication with DJI servers provides both DJI and PRC an ability to potentially shut down an AeroScope remotely or insert harmful code. These risks are especially alarming for any federal organization that has a fleet of AeroScopes connected to or accessed by government networks.

As with any computer or system attached to a network, connecting USB devices presents risks, ranging from introducing unknown code to shortening the power supply life. In this context, it remains uncertain whether the updates are 100-percent safe and non-hostile. We also don't know if they contain sleeper code or malicious functions that can be activated at a later date.

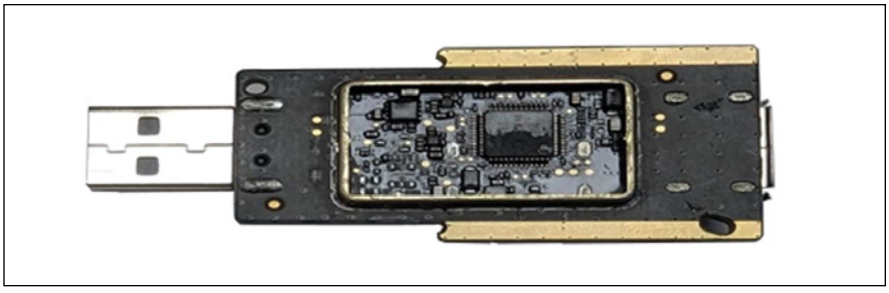
Even if the dongle does everything DJI says it will do — i.e., providing the necessary updates to enable AeroScope to work with the newly encrypted Drone ID data — the dongle could still contain malicious code designed to infiltrate networks or degrade the functionality of standalone systems.

To explore these possibilities, Edgesource has been reverse engineering the new hardware and updated firmware for the AeroScope system. What follows is our analysis.

How the Upgrade Works

The AeroScope upgrade module is an example of a significant low-level change in the Drone ID protocol structure. In this case, the upgrade implements a layer of encryption over the existing protocol, ensuring only AeroScopes with an attached upgrade module and connection back to DJI servers can successfully decrypt and process those data packages. Here is a quick overview the dongle's operations once it's plugged into the AeroScope system:

- After connecting the dongle to AeroScope, the onboard firmware performs a multi-step authentication routine. During this process, AeroScope and the dongle exchange a session key, which encrypts all further communications from the dongle.
- A significant amount of effort is spent ensuring the device connected to the dongle is an AeroScope. Once the module is authenticated, AeroScope runs like normal, including receiving information packets from older or non-updated aircraft that aren't encrypted.
- Newer aircraft send a new cryptographic key exchange packet (CRYP) of information that includes an encrypted aircraft session key, along with other necessary attributes.
- Once AeroScope receives the CRYP packet, it sends that unmodified information to the upgrade module, which returns the decrypted aircraft session key to AeroScope.
- AeroScope stores the aircraft session key and unique key hash. As it receives the original Drone ID packets of data, it decrypts them using this key.



This USB device, or dongle, provides an upgraded encryption mechanism for the AeroScope drone detection module. (Image: DJI)

Reverse Engineering Revelations

While the dongle's purported purpose is to securely store the cryptographic keys required to decrypt the Drone ID signals originating from encrypted DJI aircraft, closer inspection of the dongle has revealed that the software has extensive obfuscation. It also potentially includes geo-fencing, which would enable DJI to restrict the platform's usage in certain parts of the world. Based on our analysis of the dongle, we have also discovered:

- If there is a connected GPS antenna, AeroScope sends GPS locations to the dongle.
- The CRYPs include encrypted information from the detected UAS including the aircraft serial number and GPS position. While this data is processed by the device, only the serial number is provided to AeroScope. The rest of the data is used within the module.
- When presented with an invalid or improperly encrypted information blob, the dongle refuses to process the decryption and sends an error back to AeroScope.

Obfuscation and Firmware Update Concerns

The software obfuscation tool makes analyzing the firmware difficult and increases the upgrade file size by roughly five to ten times by including a large amount of dead code. Because these techniques are common in malware, DJI is no longer available in the Google Play Store. The obfuscation tool prevents Google from reviewing the application code, violating its store policies.

We should note, obfuscation doesn't immediately point to malicious code. It also doesn't mean DJI doesn't have a valid reason for employing source code protection. It does, however, call into question what exists within these code bases and significantly increases the cost and challenge of reviewing them for security concerns.

In addition, the updated firmware, which supports the dongles, updates AeroScope's onboard main processing binary, which manages all external communications and general processing of received detections. In previous firmware versions, this file was approximately 300 kilobytes (kB) in size and was not designed to prevent analysis. In fact, it included debugging symbols, such as function names and other data.

These new versions, on the other hand, introduce numerous obfuscation and packing concepts designed to delay or pre-

vent firmware analysis. One, for example, uses Pluto — an open-source low-level virtual machine (LLVM) obfuscation tool, causing this previously 300-kB executable file to grow to roughly 2 megabytes in size.

In short, this new firmware update was obfuscated before release. Updating AeroScope to this firmware without first asking questions or understanding its contents poses a serious security risk.

What Do We Do Now?

In order to maintain the necessary visibility to identify, track, monitor and potentially mitigate DJI drones used against us or are for illegal activities, we must have a way to decrypt the Drone ID data. At this time, an upgraded AeroScope is the most direct way to maintain that visibility, whether deployed as a standalone system or as a component of an advanced sensor such as Windtalker.

In partnership with the DoD's Defense Innovation Unit (DIU), WindTalker was developed by Edgesource, which was tasked with cyber-wrapping AeroScope, enabling it to safely operate without DJI influence. Windtalker maintains AeroScope's functionality but isolates the system, severing all connections to foreign governments and allowing only your server to see the drone data.

In addition to implementing WindTalker, we recommend the following actions to further mitigate security risks:

Edgesource's Windtalker, pictured here, is a cyber-wrapped passive detection device capable of locating the pilot, home point and flight path for up to 400+ drones simultaneously. (Image: Edgesource)

- **Make sure the systems you're using are secure.** This means performing a full security analysis, including specific risks related to each deployment of an AeroScope system before upgrading the AeroScope firmware or attaching the new upgrade module.
- **Find out if you or your vendor already upgraded your AeroScope.** We understand that inevitably some AeroScope upgrade modules have already been installed. In this case, we recommend performing a security assessment to determine the risk impacts and any mitigations necessary.
- **Reverse engineer the upgrade module to fully understand what it contains.** In addition to providing vital decryption of now-encrypted DJI Drone ID data, the upgrade module gives us valuable insight into the inner workings of DJI. Reverse engineering the module can help us develop a solution that can perform the same necessary functions of the module — but without introducing the risks that come with a foreign-manufactured hardware and software solution.
- **Invest in U.S. domestic or allied small UAS solutions.** There is a global imbalance in manufacturing sUAS equipment and sensors, creating a vulnerability in security, supply chain, data and other capabilities.

Resources

- DJI AeroScope Release Notes (2023).
- Executive Order on Protecting the U.S. From Certain Unmanned Aircraft Systems (2021).
- Addition of Entities to the Department of Commerce's Entity List (2020).
- Pentagon Memo Grounds Air Force Special Ops Quadcopters (2018).

This article was written by Daniel Flack, Senior Subject Matter Expert, Unmanned and Counter-Unmanned Systems, Edgesource Corp. (Alexandria, VA). **For more information, visit www.edgesource.com.**

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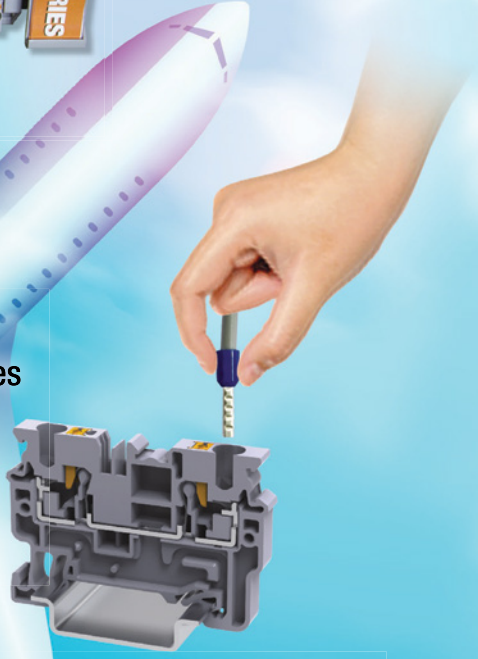

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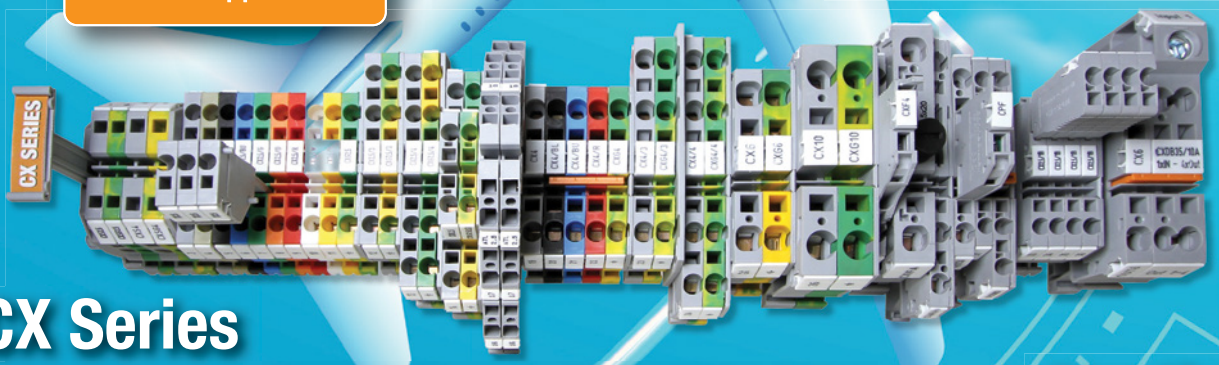

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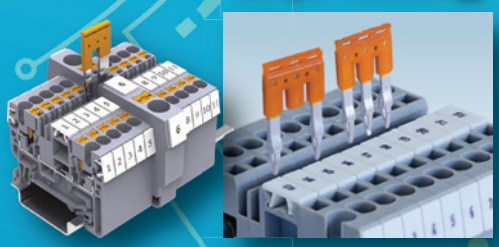

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AI Automates Drone Defense With *High Energy Lasers*

Lasers enable the U.S. Navy to fight at the speed of light. Armed with artificial intelligence (AI), ship defensive laser systems can make rapid, accurate targeting assessments necessary for today's complex and fast-paced operating environment where drones have become an increasing threat.

To counter the rapidly mounting threats posed by the proliferation of inexpensive uncrewed autonomous systems (UAS), or drones, Naval Postgraduate School (NPS) researchers and collaborators are applying AI to automate critical parts of the tracking system used by laser weapon systems (LWS). By improving target classification, pose estimation, aimpoint selection and aimpoint maintenance, the ability of an LWS to assess and neutralize a hostile UAS greatly increases. Enhanced decision advantage is the goal.

The tracking system of an LWS follows a sequence of demanding steps to successfully engage an adversarial UAS. When conducted by a human operator, the steps can be time consuming, especially when facing numerous drones in a swarm. Add in the challenges of an adversary's missiles and rockets traveling at hypersonic speeds, efforts to mount proper defenses become even more complicated, and urgent.

Directed energy and AI are both considered DoD Critical Technology Areas. By automating and accelerating the sequence for targeting drones with an AI-enabled LWS, a research team from NPS, Naval Surface Warfare Center Dahlgren Division, Lockheed Martin, Boeing and the Air Force Research Laboratory (AFRL) developed an approach to have the operator on-the-loop overseeing the tracking system instead of in-the-loop manually controlling it.

"Defending against one drone isn't a problem. But if there are multiple drones, then sending million-dollar interceptor missiles becomes a very expensive tradeoff because the drones are very cheap," says Distinguished Professor Brij Agrawal, NPS Department of Mechanical and Aerospace Engineering, who leads the NPS team. "The Navy has several LWS being developed and tested. LWS are cheap to fire but expensive to build. But once it's built, then it can keep on firing, like a few dollars per shot."

To achieve this level of automation, the researchers generated two datasets that contained thousands of drone images and then applied AI training to the datasets. This produced an AI model that was validated in the laboratory and then transferred to Dahlgren for field testing with its LWS tracking system.

Image: Andrii/Adobe Stock

Funded by the Joint Directed Energy Transition Office (DE-JTO) and the Office of Naval Research (ONR), this research addresses advanced AI and directed energy technology applications cited in the CNO NAVPLAN.

Left: The Laser Weapons System Demonstrator (LWSD) – a solid-state, high-energy infrared laser tested by USS Portland (LPD 27) – is shown high above the deck at the bow just ahead of the ship's superstructure. (U.S. Marine Corps photo by Staff Sgt. Donald Holbert) Right: The LWSD successfully engaged aerial and surface training targets. Because the laser beam is invisible to the human eye, a short-wavelength infrared (SWIR) lens and optical filter were used to show the LWSD striking its target. (Image: U.S. Navy)

Engaging Drones with Laser Weapon Systems

During a typical engagement with a hostile drone, radar makes the initial detection and then the contact information is fed over to the LWS. The operator of the LWS uses its infrared sensor, which has a wide field of view, to start tracking the drone. Next, the high magnification and narrow field of view of its high energy laser (HEL) telescope continues the tracking as its fast-steering mirrors maintain the lock on the drone.

With a video screen showing the image of the drone in the distance, the operator compares it to a target reference to classify the type of drone and identify its unique aimpoints. Each drone type has different characteristics, and its aimpoints are the locations where that particular drone is most vulnerable to incoming laser fire.

Along with the drone type and aimpoint determinations, the operator must identify the drone's pose, or relative orientation to the LWS, necessary for locating its aimpoints. The operator looks at the drone's image on the screen to determine where to point the LWS and then fires the laser beam.

Long distances and atmospheric conditions between the LWS and the drone can adversely affect the image

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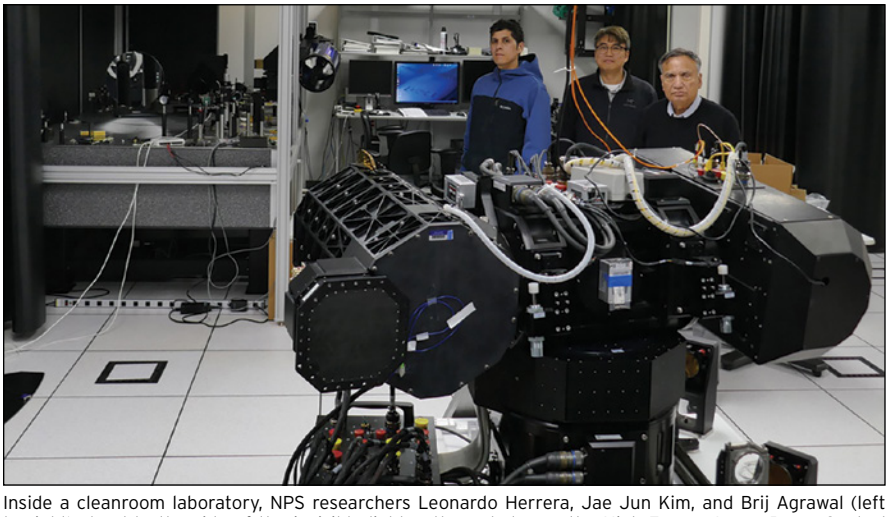
quality, making all these identifications more challenging and time consuming to conduct.

After all these preparations, the operator cannot just simply move a computerized crosshair across the screen onto an aimpoint and press the fire button as if it were a kinetic weapon system, like an anti-aircraft gun or interceptor missile.

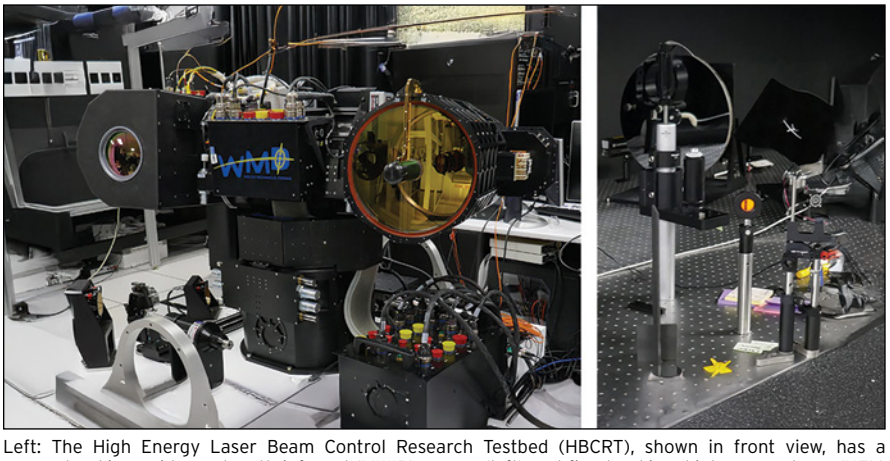
Though lasers move at the speed of light, they don't instantaneously destroy a drone like the way lasers are depicted in sci-fi movies. The more powerful the laser, the more energy it delivers in a given time. To heat a drone enough to cause catastrophic damage, the laser must be firing the entire time.

But there's a catch. The laser beam must be continually held at the same spot.

If the drone continuously moves, then the laser beam will wander along its surface if not continuously re-aimed. In this case, the laser's energy will be distributed across a large area instead of concentrated at a single point. This process of continuously firing the laser beam at one spot is called aimpoint maintenance.



Inside a cleanroom laboratory, NPS researchers Leonardo Herrera, Jae Jun Kim, and Brij Agrawal (left to right) stand to the side of the invisible light pathway between the High Energy Laser Beam Control Research Testbed (HBCRT), rear view in foreground, and the range-in-a-box (RIAB), in background. The HBCRT replicates a laser weapon system (LWS) found aboard a ship, and the RIAB uses an optical bench and a miniature model to simulate a full-size drone in flight about 5 kilometers away. The researchers collected thousands of target images for AI training and development of an AI model that automates LWS target classification, pose estimation, aimpoint selection and aimpoint maintenance. (Image: U.S. Navy)



Left: The High Energy Laser Beam Control Research Testbed (HBCRT), shown in front view, has a course-tracking, mid-wavelength infrared (MWIR) sensor (left) and fine-tracking, high energy laser (HEL) telescope (right). The 30 cm-diameter telescope has the capability to fire a 1-kilowatt laser beam, though it's not fired for this particular research. Right: The range-in-a-box (RIAB) has a large parabolic mirror and other optical components. At the top right and in front of a black background, a 3D-printed miniature model of a drone is mounted on a gimble that can change its pose (relative orientation to the LWS) along the three rotational axes of flight: roll (x), pitch (y), and yaw (z). (Image: U.S. Navy)

In 2016, construction of the High Energy Laser Beam Control Research Testbed (HBCRT) was completed by the NPS research team. The HBCRT was designed to replicate the functions of an LWS found aboard a ship, such as the 30-kilowatt, XN-1 Laser Weapon System operated on USS Ponce (LPD 15) from 2014 to 2017.

Now the HBCRT is also being used to create catalogs of drone images to make real-world datasets for AI training.

Built by Boeing, the HBCRT has a 30 cm diameter, fine-tracking, HEL telescope and a course-tracking, mid-wavelength infrared (MWIR) sensor. The pair is called the beam director when coupled together on a large gimble that swivels them in unison up-and-down and side-to-side.

"The MWIR is thermal," says Research Associate Professor Jae Jun Kim, NPS Department of Mechanical and Aerospace Engineering, who specializes in optical beam control. "It looks at the mid-wavelength infrared signal of light, which is related to the heat signature of the target. It has a wide field of view. The gimbal moves to lock onto the target. Then the target is seen through the telescope, which has very small field of view."

A 1-kilowatt laser beam (roughly a million times more powerful than a classroom laser pointer) can fire from the telescope. If the laser beam were to be used, it's generated by a separate external unit and then directed into the telescope, which then projects the laser beam onto the target. However, its use with the HBCRT isn't required for the initial development of this research, which allows the work to be easily conducted inside a laboratory.

With a short-wavelength infrared (SWIR) tracking camera, the telescope can record images of a drone that is miles away. Although necessary, replicating the view of a distant drone in a small laboratory is impossible. To resolve this dilemma, researchers mounted 3D-printed, titanium miniature models of drones fabricated by AFRL into a range-in-a-box (RIAB).

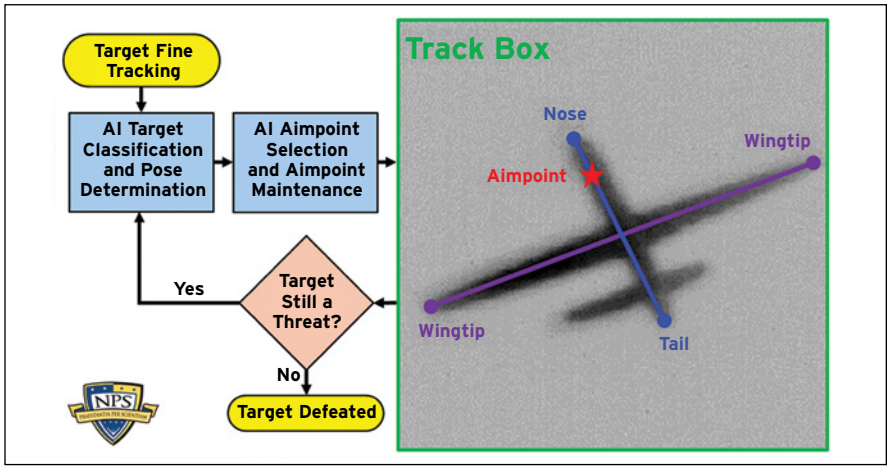
Constructed on an optical bench, the RIAB accurately replicates a drone flying miles away from the telescope by

using a large parabolic mirror and other optical components. This research used a miniature model of a Reaper drone. When a SWIR image is taken of the drone model by the telescope, it appears to the telescope as if it were seeing an actual full-sized Reaper drone.

The drone model is attached to a gimble with motors that can change its pose along the three rotational flight axes of roll (x), pitch (y) and yaw (z). This allows the telescope to observe real-time changes in the direction that the drone model faces.

Simply put, pose is the orientation of the drone that the telescope "sees" in its direct line of sight. Is the drone heading straight-on or flying away, diving or climbing, banking or cruising straight and level, or moving in some other way?

By measuring the angles about the x-, y- and z-axes for a drone model in a specific orientation, the pose of the drone can be precisely defined and recorded.



AI can automate the engagements with adversarial drones by laser weapon systems (LWS), leaving the human operators on-the-loop instead of in-the-loop. This allows for quicker engagements, which is especially important when facing drone swarms. The nose, tail and wingtips are key points that AI uses to identify a drone's classification, pose and aimpoints. (Image: U.S. Navy)

This article was written by Dan Linehan for the Naval Postgraduate School. It has been edited. To learn more about the AI models and data sets used in this research, and to read the full article, visit www.nps.edu.

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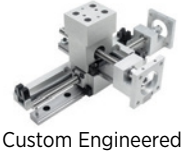
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Human-Focused Research Aims to Enhance UAS Effectiveness, Readiness

Researchers at the U.S. Army Aeromedical Research Laboratory are trying to enhance the effectiveness of drones in combat by improving protocols for human-machine teaming.

U.S. Army Aeromedical Research Laboratory, Fort Detrick, MD

As the capabilities of unmanned aerial systems continue to evolve rapidly in response to the tactical and strategic necessities of the modern battlefield, the U.S. Army Aeromedical Research Laboratory is exploring a unique approach to improving their operational effectiveness – by focusing on the protection and performance of UAS operators.

"USAARL is putting the 'human' in human-machine teaming," says Dr. Bethany Ranes, a sensory scientist with USAARL's Warfighter Performance Group. "It's easy to overlook the fact that while the vehicle itself may be unmanned, it will always be operated by a human. And because human operators are an integral part of human-machine teaming, it's essential that we maximize that relationship."

UAS has transformed the modern battlefield, providing capabilities ranging from reconnaissance, surveillance, and target acquisition to precision strikes. Even their mere presence can have a significant deterrent effect on the battlefield. These capabilities have been made possible through advances in data analytics, sensor technologies, propulsion systems, and autonomous navigation. Unmanned aircraft can reduce the risk of Warfighter injury and death, improve real-time surveillance capability, typically cost less than comparable manned aircraft, and can be adapted to meet rapidly changing mission requirements.

However, progress in human-machine integration has not always kept pace with the rapid developments of UAS technologies. To close that gap, Ranes' team is actively conducting research in several key areas including the use of adaptive automation to assist in workload management, improved understanding of operator health and performance, updated training and testing protocols, and the legal, ethical, and policy considerations related to the use of UAS in MEDEVAC scenarios.

Col. Samuel Fricks, chief of the Medical Evacuation Concepts and Capabilities Directorate, discusses UAS with an industry partner at the Unmanned Aircraft Systems (UAS) Summit at Fort Novosel. (Image: Leslie Herlick)

A drone demonstrates the capabilities of their platform during the UAS Summit at Fort Novosel. (Image: Leslie Herlick)

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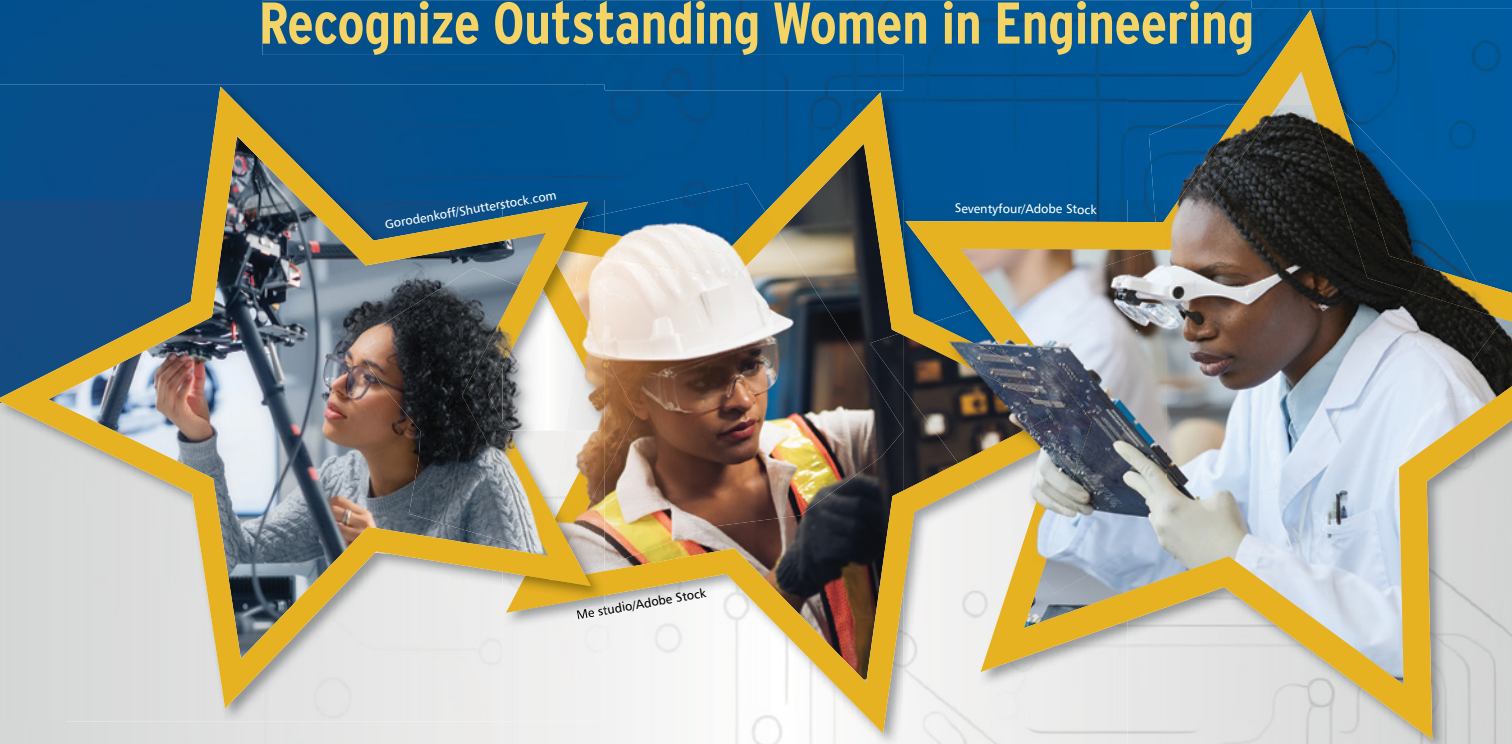

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One of the biggest concerns in UAS operations is the tendency for operators to become overly reliant on automation. USAARL researchers believe this issue, which they call the out-of-the-loop problem, can have significant health impacts in addition to operational ones.

"If you're out of the loop, you can't react very well when something happens suddenly, so it can be very dangerous," says Ranes. "On top of that, when you're spending hours and hours doing something that's disengaging and boring, it's terrible for brain health. It leaves you more vulnerable to trauma effects and attention deficit issues."

Ranes, a cognitive neuroscientist who focused on developing techniques for improving engagement with human-machine interfaces before joining USAARL, sees the increasing investment in UAS as an opportunity for the laboratory to conduct innovative, world-leading aeromedical research.

"What I think is most exciting about UAS is that it is a really new frontier for understanding human cognition," says Ranes. "It's an opportunity for us to ask what we can do to optimize the aspects of the vehicle and retain the optimal function of humans. Because no matter what, at the end of the day technology is still light years behind what a human brain can do."

Along with USAARL Commander Col. Matthew Hoefer, Ranes recently spoke to representatives of the Army's UAS community and systems developers about the laboratory's efforts to close gaps in human-machine interfaces, scalable autonomy, and autonomous MEDEVAC during the Unmanned Aircraft Systems Summit at Fort Novosel in February. The four-day summit, hosted by the U.S. Army Aviation Capability Development Integration Directorate, was one of a series of meetings designed to ensure the Army's UAS modernization effort stays in tune with current battlefield experience and Army requirements.

"It's a lot easier to measure the performance of a machine than the performance of a human being," explained Hoefer during the summit. "If we can use physiological monitoring to measure human performance while we're also measuring the performance of the machine, then we can tie those two together and create a symbiosis. And then you will have a sliding scale of workload management where, if the human is overwhelmed, the machine can take over, and if the human is able to do more complicated tasks, the machine can draw down. And if you lose the human due to impairment, adaptive autonomy enables the machine to take over and continue the mission."

At the next summit, scheduled for August, USAARL plans to demonstrate its recent efforts to team multisensory research with future UAS control systems to increase operator performance.

"When we're talking about UAS, we're really getting into the realm of science fiction," says Ranes. "Humans don't have the evolutionary experience to intuitively know how to fly, but we have taught ourselves how. Moving as rapidly as we are, to be successful we're going to have to really think about the most human way to operate UAS."

This article was written by Paul Lagasse, a writer for the U.S. Army Medical and Research Command. **For more information, visit www.usaarl.health.mil.**

Engineers Enable a Drone to Determine Its Position in the Dark and Indoors

A new low-power system using radio frequency waves takes a major step toward autonomous, indoor drone navigation.

Massachusetts Institute of Technology, Cambridge, MA

In the future, autonomous drones could be used to shuttle inventory between large warehouses. A drone might fly into a semi-dark structure the size of several football fields, zipping along hundreds of identical aisles before docking at the precise spot where its shipment is needed.

Most of today's drones would likely struggle to complete this task, since drones typically navigate outdoors using GPS, which doesn't work in indoor environments. For indoor navigation, some drones employ computer vision or LIDAR, but both techniques are unreliable in dark environments or rooms with plain walls or repetitive features.

MIT researchers developed a system that enables a drone to determine its position in 6D space in indoor, dark, or low-visibility environments using radio frequency waves. The drone has 2 radars; the horizontal radar has a horizontal polarization, which means it sends signals horizontally, while the vertical radar would have a vertical polarization. (Image: MIT News)

MIT researchers have introduced a new approach that enables a drone to self-localize, or determine its position, in indoor, dark, and low-visibility environments. Self-localization is a key step in autonomous navigation.

The researchers developed a system called MiFly, in which a drone uses radio frequency (RF) waves, reflected by a single tag placed in its environment, to autonomously self-localize.

Because MiFly enables self-localization with only one small tag, which could be affixed to a wall like a sticker, it would be cheaper and easier to implement than systems that require multiple tags. In addition, since the MiFly tag reflects signals sent by the drone, rather than generating its own signal, it can be operated with very low power.

Two off-the-shelf radars mounted on the drone enable it to localize in relation to the tag. Those measurements are fused with data from the drone's onboard computer, which enables it to estimate its trajectory.

The researchers conducted hundreds of flight experiments with real drones in indoor environments, and found that MiFly consistently localized the drone to within fewer than 7 centimeters.

"As our understanding of perception and computing improves, we often forget about signals that are beyond the visible spectrum. Here, we've looked beyond GPS and computer vision to millimeter waves, and by doing so, we've opened up new capabilities for drones in indoor environments that were not possible before," says Fadel Adib, associate professor in the Department of Electrical Engineering and Computer Science, director of the Signal Kinetics group in the MIT Media Lab, and senior author of a paper on MiFly.

Adib is joined on the paper by co-lead authors and research assistants Maisy Lam and Laura Dodds; Aline Eid, a former postdoc who is now an assistant professor at the University of Michigan; and Jimmy Hester, CTO and co-founder of Atheraxon, Inc. The research will be presented at the IEEE Conference on Computer Communications.

Backscattered Signals

To enable drones to self-localize within dark, indoor environments, the researchers decided to utilize millimeter wave signals. Millimeter waves, which are commonly used in modern radars and 5G communication systems, work in the dark and can travel through everyday materials like cardboard, plastic, and interior walls.

They set out to create a system that could work with just one tag, so it would be cheaper and easier to implement in commercial environments. To ensure the device remained low power, they designed a backscatter tag that reflects

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millimeter wave signals sent by a drone's onboard radar. The drone uses those reflections to self-localize.

But the drone's radar would receive signals reflected from all over the environment, not just the tag. The researchers surmounted this challenge by employing a technique called modulation. They configured the tag to add a small frequency to the signal it scatters back to the drone.

"Now, the reflections from the surrounding environment come back at one frequency, but the reflections from the tag come back at a different frequency. This allows us to separate the responses and just look at the response from the tag," Dodds says.

However, with just one tag and one radar, the researchers could only calculate distance measurements. They needed multiple signals to compute the drone's location.

Rather than using more tags, they added a second radar to the drone, mounting one horizontally and one vertically. The horizontal radar has a horizontal polarization, which means it sends signals horizontally, while the vertical radar would have a vertical polarization.

They incorporated polarization into the tag's antennas so it could isolate the separate signals sent by each radar.

"Polarized sunglasses receive a certain polarization of light and block out other polarizations. We applied the same concept to millimeter waves," Lam explains.

In addition, they applied different modulation frequencies to the vertical and horizontal signals, further reducing interference.

Precise Location Estimation

This dual-polarization and dual-modulation architecture gives the drone's spatial location. But drones also move at an angle and rotate, so to enable a drone to navigate, it must estimate its position in space with respect to six degrees of freedom — with trajectory data including pitch, yaw, and roll in addition to the usual forward/backward, left/right, and up/down.

"The drone rotation adds a lot of ambiguity to the millimeter wave estimates. This is a big problem because drones rotate quite a bit as they are flying," Dodds says.

They overcame these challenges by utilizing the drone's onboard inertial measurement unit, a sensor that measures acceleration as well as changes in altitude and attitude. By fusing this information with the millimeter wave measurements reflected by the tag, they enable MiFly to estimate the full six-degree-of-freedom pose of the drone in only a few milliseconds.

They tested a MiFly-equipped drone in several indoor environments, including their lab, the flight space at MIT, and the dim tunnels beneath the campus buildings. The system achieved high accuracy consistently across all environments, localizing the drone to within 7 centimeters in many experiments.

In addition, the system was nearly as accurate in situations where the tag was blocked from the drone's view. They achieved reliable localization estimates up to 6 meters from the tag.

That distance could be extended in the future with the use of additional hardware, such as high-power amplifiers, or by improving the radar and antenna design. The researchers also plan to conduct further research by incorporating MiFly into an autonomous navigation system. This could enable a drone to decide where to fly and execute a flight path using millimeter wave technology.

"The infrastructure and localization algorithms we build up for this work are a strong foundation to go on and make them more robust to enable diverse commercial applications," Lam says.

This article was written by Adam Zewe, a writer at Massachusetts Institute of Technology. **For more information, contact Melanie Grados at mgrados@mit.edu.**

Low Cost Air Traffic Control for Drones

As the increase in civilian drones poses the risk of safety issues in congested airspace, researchers at BYU have introduced a new approach to lowering the cost of air traffic surveillance for low-flying drones.

Brigham Young University, Provo, UT

With the exponential rise in drone activity, safely managing low-flying airspace has become challenging — especially in highly populated areas. Just last month an unauthorized drone collided with a 'Super Scooper' aircraft above the Los Angeles wildfires, grounding the aircraft for several days and hampering the firefighting efforts.

Traditional radar systems are powerful but cannot effectively detect low-flying aircraft below 400 feet. While the Federal Aviation Administration (FAA) has some regulations to manage small, unmanned aircraft systems (UAS) or drones, tracking and safety can be problematic – especially in congested or restricted airspaces. BYU researchers may have the solution.

Using a network of small, low-cost radars, engineering professor Cammy Peterson and her colleagues have built an air traffic control system for drones that can effectively and accurately track anything in an identified low-altitude airspace.

"Radar has been around for a long time," said Karl Warnick, co-author and BYU professor of electrical and computer engineering. "Instead of having a $10 million spinning dish like you'd see at an airport, we have a simple thing that could be built for a few hundred dollars. The small radars don't have all the capabilities of a higher-end radar, but a network of small radars can work together effectively."

Peterson explained how the drone air traffic control system works:

(Image: Nate Edwards/BYU Photo)

- Multiple ground station computers are connected to radar units, which are distributed around an area.
- These radar units are pointed toward the sky to detect any moving objects within their field of view.
- When a radar unit identifies an object, it records the position of that object in addition to the radar unit itself.
- This information is then converted to a global coordinate frame to be shared with other ground stations to create a comprehensive, time-varying picture of air traffic in the area.

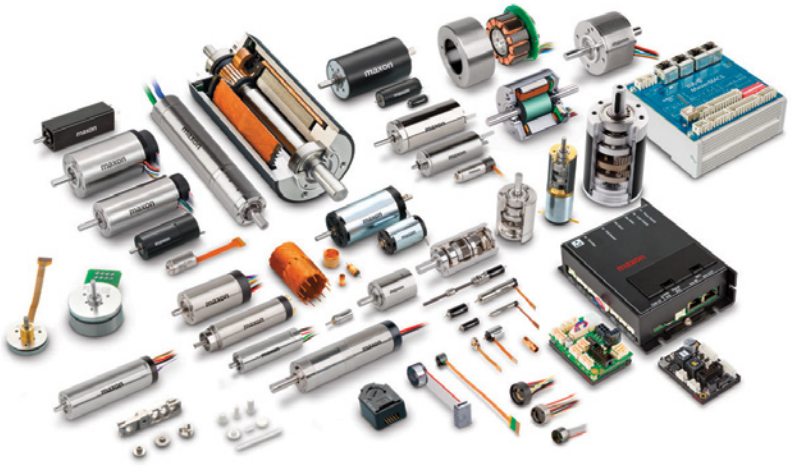
This conversion allows all ground stations to accurately interpret the object's position in real space, Peterson said. To achieve a dynamic air traffic picture, each radar unit must be calibrated or provided with the necessary data to convert from the local frame to the global frame.

"Each radar has a field of view as it's pointed up at the sky," said fellow researcher Tim McLain, a BYU professor of mechanical engineering. "You want the radars to be calibrated so they all see an individual aircraft at the same place in the sky,"

Researchers said the small radars could potentially be installed on structures such as light posts or cell towers.

Peterson recently published a paper about tracking drones with their air traffic control system, explaining that their research, completed using funding provided by the National Science Foundation, provides more certainty about real-time drone location — important when considering how to prevent collisions between drones.

While the BYU researchers focused on three radars — each able to track a circular airspace about 500 feet across — the



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technology could be scaled to a broader network with many radars.

"One company (like Amazon or Walmart) can't take the whole airspace for an hour, right?" Peterson said. "To be cost effective you need to allow multiple vehicles from different companies to travel through the same area during the same time window. If you want to be safe, you'll want to know where the other drones are at."

The effectiveness of the system could be compromised due to weather or an object that bumps into a physical radar unit, causing it to move and point in an unintended direction. But an online calibration allows the radar units to adjust for an inadvertent change in its position as it is collecting data, and to correct for any problems."

"An exciting aspect of this air traffic control system is that in the course of 10 seconds, our radars can correct for a unit's new position," said graduate student and co-author Brady Anderson.

To come to the 10-second correction time, Anderson focused on a mathematical equation that performs the online calibration. The research team demonstrated that this dynamic calibration technique showed clear improvements over research with recorded or "batch" data.

Peterson said that with the algorithms driving the system, the radar units could be swapped out or more could be added, allowing for different capabilities depending on the needs.

This article was written by Sharman Gill, a writer for BYU University Communications. **For more information, visit www.byu.edu.**

Unmanned Aircraft Systems Help Responders in Urban Environments

The Science and Technology Directorate's (S&T) National Urban Security Technology Laboratory (NUSTL) recently brought together emergency responders from across the nation to test unmanned aircraft systems (UAS) from the Blue UAS Cleared List. By providing an aerial vantage point, and creating standoff distance between responders and potential threats, UAS can significantly mitigate safety risks to responders by allowing them to assess and monitor incidents remotely.

U.S. Department of Homeland Security, Washington, D.C.

In November 2024, the U.S. Department of Homeland Security's (DHS) National Urban Security Technology Laboratory (NUSTL) teamed up with Mississippi State University's (MSU) Raspet Flight Research Laboratory, and DAGER Technology LLC, to conduct an assessment on selected models of cybersecure "Blue UAS." The drones, including models from Ascent AeroSystems, Freefly Systems, Parrot Drones, Skydio, and Teal Drones, are cybersecure and commercially available to assist emergency responders with their public safety operations.

These evaluations were a continuation of previous tests held in rural Texas last June. The overall goal was to assess various capabilities (e.g., camera visual acuity, latency, and command and control link quality) in different geographic settings and terrain.

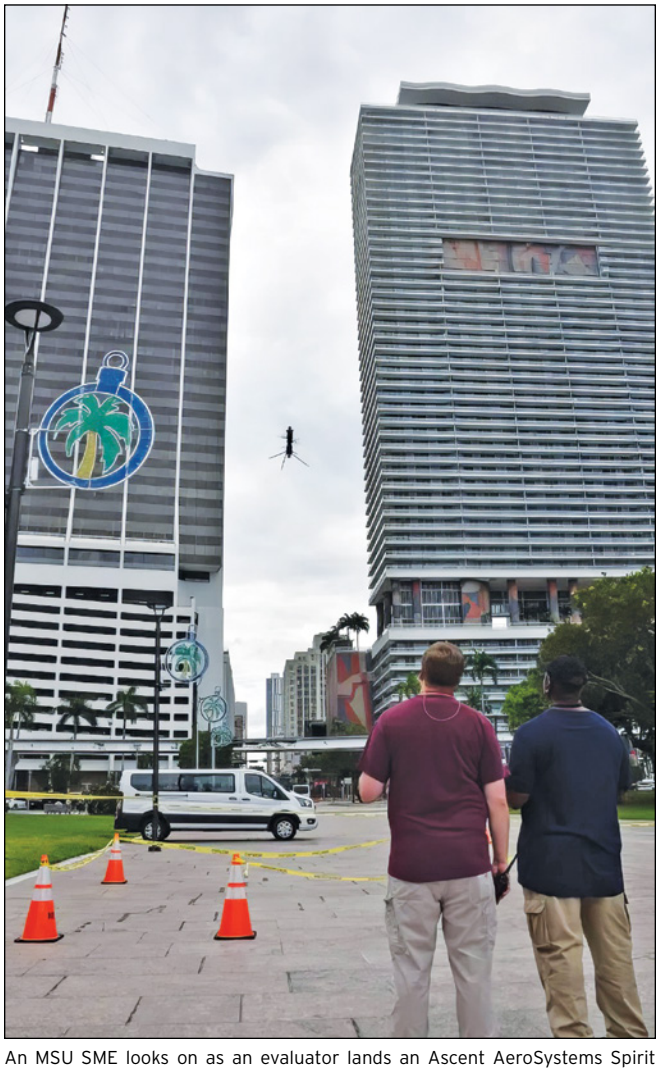
Bayfront Park provided ideal urban environments for the team to conduct their Blue UAS assessments. (Image: NUSTL)

"We flew select Blue List UAS at both Bayfront Park and LoanDepot Park in Miami," said NUSTL Program Analyst Kris Dooley. "Our goal was to assess their unique technologies and capabilities, and also gauge their suitability for first responder use during damage assessments and situational awareness missions in urban environments."

Responders also assessed how quickly the UAS could be deployed and how well they convey vital information in real time.

"Urban environments can be challenging for first responders using UAS, due to the presence of public transportation, multi-story buildings, increased light pollution, and dense populations. High amounts of radiofrequency noise

A first responder uses a ground control station from a Parrott ANAFI USA GOV drone to observe Bayfront Park while conducting a flyover. (Image: NUSTL)



An MSU SME looks on as an evaluator lands an Ascent AeroSystems Spirit drone in Bayfront Park during a damage assessment scenario. (Image: NUSTL)

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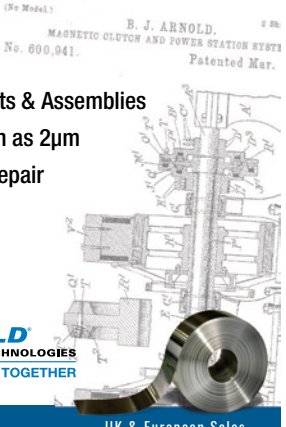

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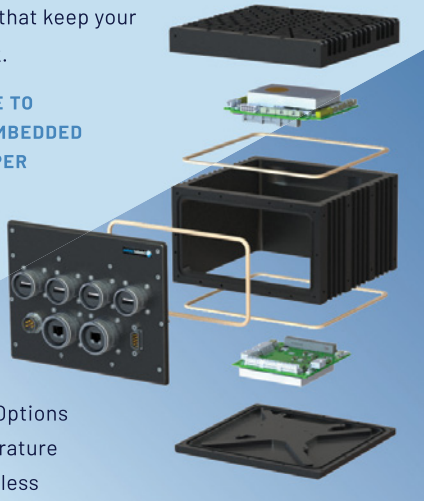

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A first responder looks at a Teal 2 drone GCS while observing the infield of LoanDepot Park during a night operations scenario. (Image: NUSTL)

can also interfere with signals between the drones and their GCS," Dooley explained.

Dozens of flights occurred during day and night conditions, and in varying scenarios and environments. Participating first responders tested whether the UAS systems had the capabilities required to help them quickly and accurately survey urban emergency sites for infrastructure damage; identify suspects or victims; and locate safe entry and exit routes for fellow emergency responders.

To assess the UAS in the field, first responder evaluators conducted a series of operational scenarios: post-incident damage assessment, situational awareness, and nighttime operations.

The post-incident damage assessment was meant to simulate a daytime disaster relief operation. For this scenario, first responder UAS operators launched drones from the south side of Bayfront Park. They then flew them to the west side to conduct a damage assessment of an abandoned building, to locate relevant entrance and exit routes, and see if they could pinpoint points of interest in the immediate area. Information regarding site accessibility and potential hazards was relayed to emergency response teams on the ground in real time to ensure their situational awareness and safety.

The situational awareness scenario took place on the north side of Bayfront Park and included its amphitheater.

"This exercise simulated a fly-over that would take place before responders send in personnel to rescue hostages or trapped individuals," said Dooley. "UAS were flown over the amphitheater and surrounding areas to gather critical information for public safety personnel who were on scene and waiting to respond."

Evaluators tested the efficacy of the UAS cameras and video feeds to see how effectively first responder operators could assess a hostage situation at the amphitheater. "The operators were tasked with identifying hostages (depicted by mannikins); along with items such as vehicles, signage, and mock weapons, as well as their locations," Dooley explained.

The night operations scenario took place at LoanDepot Park, kicking off at dusk and continuing well into the evening. To assess the platforms in low light conditions, first responder operators launched UAS from two parking garages on the eastern side of the park and flew them in close proximity to the stadium and surrounding parking garages. They were tasked with assessing and inspecting the retractable stadium roof and associated infrastructure, locating, and identifying pre-designated vehicles that were outfitted with mannikins and mock weapons, and observing scenario participants' foot traffic around the stadium and nearby plaza to assess thermal capabilities.

"Our responders relied on both the electro-optical and infrared cameras, which are either integrated within or affixed as a payload to the UAS, to thoroughly observe the stadium roof tracks and locate assessment personnel during these exercises," Dooley continued.

"These test flights play a critical role in helping our first responder UAS operators understand how drones operate in urban settings. The data collected will be a resource for the larger national responder community as they consider acquiring Blue UAS platforms for their agency's missions." said Dooley.

Just last month, NUSTL released its Blue UAS for First Responders Market Survey Report. Based on information gathered from manufacturer and vendor websites, and internet research, this report provides guidance for emergency response agencies that are making UAS-related operational and procurement decisions. In the near future, NUSTL will publish four additional reports that address various findings identified during the assessments in Texas and Miami. They will be published on the System Assessment and Validation for Emergency Responders (SAVER) website, and serve as valuable resources for responders who are interested in purchasing and using these UAS platforms.

This article was written by researchers from the U.S. Department of Homeland Security's Science & Technology Directorate. **For more information, visit www.dhs.gov.**

Lasers Destroy Drones as Additive Manufacturing Builds Them

Rapidly fielding emerging technologies and prioritizing investments in AI, drones, and counter-drone systems, among other technologies, are key to military modernization.

Naval Postgraduate School, Monterey, CA

In February, the Joint Interagency Field Experimentation (JIFX) team at the Naval Postgraduate School (NPS) executed another highly collaborative week of rapid prototyping and defense demonstrations with dozens of emerging technology companies. Conducted alongside NPS' operationally experienced warfighter-students, the event is a win-win providing insight to accelerate potential dual-use applications.

Even though downpours from a week of heavy storms made for less-than-ideal flight conditions in the unrestricted airspace available for use during JIFX, a single-day record for sorties flown by uncrewed autonomous systems (UAS) — or drones — was broken. On the third day, 85 sorties were flown by 11 different drones at three different tactical locations — McMillan Airfield, the Combined Arms Collective Training Facility (CACTF), and the Forward Operating Base (FOB).

According to JIFX Director, retired U.S. Army Special Forces Col., Michael Richardson, "This February event was the most engaging experimentation week since before the pandemic. Part of that was the weather. The periodic heavy rain and strong winds gave our participating firms the same challenging conditions their technologies will be expected to perform if part of the fleet or force.

"I'm happy to report that all of them rose to the challenge. Several firms accomplished firsts with their systems and nearly everyone collaborated in an ad-hoc experiment or two that demonstrated their capacity to address operational challenges more effectively together."

The hard rain and wind did not even deter a laser weapon system (LWS) from zapping a steady stream of static and towed Group 1 UAS. This was the first use of an LWS at JIFX over the course of its nearly two decade-long history. During the week, 23 industry partners conducted experiments with 24 unique technologies that represented the following research areas: Communication and networking; Countering uncrewed systems (including by laser weapon systems); Cyber, cyber security and electronic warfare; Expeditionary operations (including with additive manufacturing); infrastructure and power; Precision strike, non-lethal weapons and information operations; Situational awareness; Uncrewed systems design, deployment, operation, networking and control.

Left: A Group 1 quadcopter burns after being engaged by Aurelius Systems' laser weapon system (LWS). Bottom left: Side-by-side comparison of quadcopters with and without laser damage. Right: Modular airframe components of Firestorm Labs' Tempest drone built by its xCell expeditionary additive manufacturing station. (Image: Dan Linehan)

These technologies were evaluated by DOD stakeholders from Air Force Special Operations Command (AFSOC), Army Futures Command (AFC), Department of the Navy Small Business Innovation Research Experimentation Cell (DON-SEC), Defense Threat Reduction Agency (DTRA), Joint Special Operations Command (JSOC), Navy Special Warfare (NSW), U.S. Central Command (USCENTCOM) and U.S. Transportation Command (USTRANSCOM).

JIFX lowers barriers for emerging technology companies, industry, academia, and researchers to collaborate with the

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Lasers vs. Drones, Battlefield Power, and Expeditionary Additive Manufacturing

Perched on a firing range hilltop, an LWS fielded by Aurelius Systems blasted Group 1 quadcopters at ranges of 50 and 110 meters — the longest distance that Aurelius had ever engaged a target.

"We're demonstrating that if there's a drone out there, then we can enter a sentry mode, scan an area of the sky or backdrop against the ground or a mountain, identify the drone, continue to track it as it moves around and bring the laser to bear on it," said Michael Laframboise, Aurelius' founder and chief executive officer (CEO).

The LWS used near-infrared fiber lasers, and the targeted drones were initially affixed to static mounts then later towed along by a moving target gunnery line.

Aurelius Systems fires a laser during an experiment at the Naval Postgraduate School's (NPS) quarterly Joint Interagency Field Experimentation (JIFX) event. (Image: Dan Linehan)

JIFX plays an important role in the steps of Aurelius' LWS development. "It can be difficult to get access to firing ranges if you're a small company like ours," added Laframboise. "We can come out here to test and do live destructive firing."

Aurelius intends to bring their LWS to the next JIFX event in May. Based on their successes this go-around, they're planning to use more powerful lasers and live fire at free-flying drones.

On that same hilltop, Chariot Defense pulled up in a pickup truck with its advanced high-voltage battery system, which only took up half the space in the pickup's bed. To reduce the detectability of the LWS' presence and demonstrate improved portability, the three large, heavy, noisy, inefficient, and high-thermal signature generators running on fossil fuel and powering Aurelius' LWS were disconnected.

"We provided expeditionary power solutions for a number of different experiments," said Adam Warmoth, founder and CEO of Chariot. "More and more, on today's modern battlefield, there's a demand for power — to power computers for AI, to power sensors, to power electronic warfare equipment. That's the kind of equipment you need in today's environment."

Chariot's low-signature battery system emitted very little heat and was smaller, quieter, lighter, and more efficient than just one of the three generators used by Aurelius. It not only powered successful shots of the LWS, but it also had enough remaining juice to fire over 1,000 more blasts.

Several miles away, at McMillan Airfield, Firestorm Labs had set up its mobile expeditionary additive manufacturing station called xCell. Within its two, 20-foot-long shipping container-like sections, equipment fabricated the airframe components of Firestorm's Tempest, a modular Group 2 multimission UAS.

"The idea for xCell came to fruition so that we could manufacture our drone at the edge in a contested logistics environment," said Bill Buel, Vice President of Hardware at Firestorm. "But during development, we realized there's also a much broader need for xCell as producer for spare parts and other drones. It doesn't even have to be our drones. So, we really embrace that."

The concept of flexibility continued to be exercised with Firestorm's Tempest. It carries payloads of 10–20 pounds over ranges of 100–675 miles at speeds of 75–150 mph, depending on its variable configuration and plug-and-play engine — turbojet (high speed) or pusher prop (extended range).

"We have taken an operator first approach, and we want to empower the operator to make this truly modular," Buel continued.

Inside the xCell miniature factory, the interchangeable airframe components piled up — a nosecone with a camera port, fuselage segments for payloads, wing and tail segments. But outside, Chariot arrived on the scene ready to collaborate. A large, bulky generator ran both the printing and assembly sides of xCell.

While the generator could power three to four xCells, the technologists understood that one xCell would require more power output for the complete drone making operations than a single Chariot battery could provide. But Chariot was still able to make a high voltage connection to the assembly side and provide power to run some of its components.

"We were able to power Firestorm's mobile manufacturing station off our battery, providing increased reliability, decreased fuel usage and the ability to power it at the edge where it matters," Warmoth added.

This article was written by Dan Linehan for the Naval Postgraduate School. **For more information, visit www.nps.edu.**

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Upcoming...

Webinars

Improving Rocket and Flight Vehicle Testing Under Capital Constraints

Thursday, May 15, 2025 at 2:00 pm U.S. EDT

Many in need of solutions to overcome complexities in testing for ground support, propulsion, avionics, payload systems, and bus infrastructure also need cost-efficient ways to verify each of these systems. Solutions to this challenge exist thanks to modern technology, including Hardware-in-the-Loop simulation, modular solutions for flexibility and scalability, and specific fault insertion techniques. This 60-minute webinar explores processes for creating reliable tests without exceeding capital constraints.

Speakers:

Steven Fuchs
Senior Project Engineer,
DMC

Andy Haddad
Business Development Manager,
Pickering Interfaces

Tim Rhodes
U.S. National Sales Manager,
Pickering Interfaces

Please visit www.techbriefs.com/webinar544

Powering NewSpace Missions: Navigating the Cost vs. Reliability Challenge

Wednesday, May 21, 2025 at 9:00 am U.S. EDT

As the NewSpace industry grows, there is a rising trend toward using non-space-grade power solutions to accommodate reduced launch costs and timelines. However, this shift away from traditional, radiation-hardened technology introduces new risks. Without proper qualification, lower-cost alternatives can fail prematurely, jeopardizing time, resources, and success. This 60-minute webinar will explore how experts are balancing cost and reliability to ensure low Earth orbit mission success.

Speakers:

Jeremy Ferell
Director of Engineering,
VPT

Tom Freeman
Moderator & Product Manager,
Solsta

Please visit www.techbriefs.com/webinar546

Solving Thermal Challenges in Defense: The Role of ECUs and Chillers

Thursday, May 22, 2025 at 11:00 am U.S. EDT

In modern defense applications, extreme environments and high-power electronics create complex thermal management challenges. From mobile command centers to radar systems and containerized data centers, maintaining optimal operating temperatures is mission critical. This 30-minute webinar will explore how environmental control units (ECUs) and chiller technologies provide reliable and efficient cooling for defense applications.

Speaker:

David-Paul Schulze
Engineer,
Advanced Cooling Technologies

Please visit www.techbriefs.com/webinar547

The Marines New Installation Counter UAS System

Anduril Industries
Orange County, CA
Contact@anduril.com
www.anduril.com

The U.S. Marine Corps awarded a 10-year $642 million program of record to Anduril Industries to develop and sustain their new Installation-Counter small Unmanned Aircraft Systems (I-CsUAS) technology. I-CsUAS is a platform powered by machine learning (ML) and artificial intelligence (AI) to protect Marine Corps installations globally by detecting, identifying, tracking and defeating small unmanned aircraft systems (UAS).

In a press release published in March 2025, Anduril announced the new 10-year I-CsUAS contract award, noting that it will use a "software-first approach" powered by their Lattice platform. Anduril's solution will integrate multiple sensors and effectors into an easy-to-use, shared command and control (C2) interface and uses an open architecture to enable rapid iteration and system upgrades.

The current I-CsUAS technology the Marines have been using, according to a 2022 update about the system, is a mobile tower comprised of a radar system and optical sensor that features a passive radio frequency (RF) detection capability. The system uses AI and ML to autonomously analyze sensor data and also has a separate non-kinetic defeat capability.

In 2024, the Marine Corps issued an industry solicitation to procure a new I-CsUAS capability to encompass "detecting, identifying, tracking and defeating small unmanned aircraft systems," according to the solicitation. While Anduril did not provide many details about the I-CsUAS technology they're developing for the program, the 2024 solicitation outlined the need for the upgrade. "This kill chain will encompass integrated and networked sensor nodes along with the ability to protect the defended asset both non-kinetically and kinetically as laws and policy allow. An installation security capability gap exists regarding the detection, tracking, identification, and defeat of sUAS operating under the vicinity of covered facilities and assets as described in United States Code Title 10, Section 130i," it notes.

I-CsUAS was the latest Marine Corps contract win for Anduril Industries, following a $200 million contract awarded in November to develop a C-UAS Engagement System for the Marine Air Defense Integrated System (MADIS). To meet the growing demand for its defense solutions, Anduril has invested in Arsenal-1, a first of its kind manufacturing facility that leverages software to manufacture autonomous systems at scale. Arsenal-1 will enable timely deployment of systems worldwide while maintaining the flexibility to adapt to future defense needs.

www.anduril.com

BlueHalo Completes Test of Next Generation C-UAS Missile

BlueHalo
Arlington, VA
paul.frommelt@bluehalo.com
www.bluehalo.com

BlueHalo, the company transforming the future of global defense with actively deployed and operationally proven Counter-Uncrewed Aerial System (C-UAS) solutions, announced the successful live fire demonstration of its Next-Generation C-UAS Missile (NGCM) – Freedom Eagle-1 (FE-1), addressing the critical need for munitions industrial base expansion to meet the rapidly evolving advanced aerial threats.

During the first Controlled Test Vehicle (CTV) live fire demonstration held in January at Yuma Proving Ground, Team BlueHalo conducted three missile test flights. In each of the three tests, FE-1 launched successfully and performed its flight as planned, affirming BlueHalo's commitment to a rapid development schedule. The team collected video, system and sensor data logs, radar tracks, and RF diagnostics data from each flight test to evaluate the missile's guidance, navigation, and control systems and analyze aerodynamic models to drive down significant technical risk associated with the program.

"Going three for three on the first ever launch during the development of a new kinetic missile program is an astounding engineering feat and a testament to our team's incredible dedication and expertise," said James Batt, BlueHalo Chief Growth Officer.

The recent demonstration is the latest in a string of FE-1 milestones. Last June, BlueHalo announced its selection as one of two vendors chosen to continue development of the NGCM by the U.S. Army Combat Capabilities Development Command Aviation & Missile Center (CCDC AvMC) Aviation & Missile Technology Consortium® (AMTC). In August, the company announced the completion of multiple rounds of testing for the FE-1, including the successful firing of its dual-thrust, solid rocket motor.

In December, BlueHalo successfully completed warhead detonation testing, which collected impact data against simulated targets. Test data included penetration depths, velocities, impacts, and panel frag patterns, which will be used to confirm FE-1's lethality predictions and support continued warhead development.

"While competitors in the NGCM program remain focused on conceptual presentations, BlueHalo is actively building and testing flight hardware," said Batt. "Team BlueHalo went from paper design to first flight in 107 days, demonstrating incredible innovation and a commitment to the NGCM program."

BlueHalo's continued investment and acceleration in the development of FE-1 – with a planned customer live-fire demonstration in 3Q 2025 – is in response to legislative affirmation to this capability is a priority of growing importance. FE-1 is a critical response to the evolving UAS threat landscape. Supported by Congressional oversight, significant budgetary allocations, and the recognition of current system limitations, it addresses the need for enhanced range, lethality, and adaptability. This missile ensures a layered, cost-effective defense strategy, protecting national security interests against increasingly sophisticated drone threats.

"It's clear that the new administration wants middle-tier acquisition going faster and fielding technology quicker," said Jonathan Moneymaker, BlueHalo Chief Executive Officer. "Additionally, Congress is supportive of additional effectors to get longer range, at higher altitudes, against a threat that is evolving faster than we can keep pace with current systems. We're moving at the speed necessary to meet the need, even if it requires our own internal funding to make it happen."

BlueHalo's FE-1 is designed to counter larger UAS (Group 3 and above) with enhanced maneuverability, range, and rapid launch capabilities. This addresses the limitations of current systems, which cannot effectively engage advanced, larger drones.

www.bluehalo.com

GOKBERK C-UAS Testing

Aselan
Ankara, Turkey
www.aselan.com

Turkish defense company Aselan completed testing of its mobile laser counter unmanned aircraft system (C-UAS) platform GÖKBERK against first person view (FPV) drones in March. Previously proven effective against rotary- and fixed-wing kamikaze drones, GÖKBERK has now demonstrated its capabilities for detecting, autonomously tracking, and eliminating FPV drones across multiple test scenarios.

GÖKBERK is being developed by Aselan as a component of Turkey's next generation air defense weapon system that enables kinetic and non-kinetic defeat of threats such as miniature UAVs and IEDs. Developed with contributions from key industry partners including TÜBİTAK BİLGEM, all major subcomponents of GÖKBERK have been designed and produced domestically in Turkey.

GÖKBERK brings together ASELSAN's İHTAR platform and the laser weapon on a platform with 6 × 6 mobile deployment capability instead of a distributed architecture.

GÖKBERK uses an indigenous laser source with high beam quality for hard kill destruction of targets, while also providing soft kill destruction with an electronic jammer developed by Aselan. The system can perform very precise target tracking with various electro-optical systems on the guidance unit. With artificial intelligence (AI)-supported algorithms, the system's

tracking and identification capabilities are maximized, which enables GÖKBERK to destroy the threats in the target set in a very short time.

GÖKBERK will play a critical role in the defense of fixed facilities such as military bases, airports, power plants and oil refineries, and will have a wide range of applications thanks to its mobile deployment capability. With the data obtained from the firing tests and trials of GÖKBERK conducted under different weather conditions, improvement and development work on the system continues.

www.aselan.com

Autonomous Software

L3Harris Technologies (Melbourne, FL) has introduced AMORPHOUS™, its new software that features a single user interface to operate thousands of autonomous assets simultaneously. Designed with an open architecture, this software enables the United States and allied militaries to control a mix of uncrewed platforms, payloads and systems, even if another manufacturer produces them. AMORPHOUS, which stands for Autonomous Multi-domain Operations Resiliency Platform for Heterogeneous Unmanned Swarms, includes an intuitive and distributed command-and-control interface to give operators the flexibility to conduct a wider array of intricate military missions. This collaborative autonomy at scale will provide warfighters with a decisive overmatch capability.

www.l3harris.com

Thermal Power Sensor

Rohde & Schwarz (Munich, Germany) presents the new R&S NRP140TWG(N) thermal power sensor, designed to meet the growing demands of applications in the F band utilizing a WR 8 waveguide connector. The NRP140TWG(N) is fully traceable to the National Metrology Institute (NMI) in Germany (PTB) and is temperature compensated, ensuring accurate and reliable measurements. The new R&S NRP140TWG(N) follows the excellent R&S NRP170TWG power sensor which was the first thermal power sensor to cover the full D band. With the new sensor, Rohde & Schwarz now also offers a dedicated solution for precise power measurements in the F band, using an WR 8 waveguide connector.

www.rohde-schwarz.com

GNSS Receiver Variants

SBG Systems (Carrières-sur-Seine, France) announced an expansion of its high-performance inertial navigation systems, Ekinox, Apogee, and Navsight, with new GNSS receiver options. Until now, our inertial navigation solutions integrated a state-of-the-art triple-band GNSS receiver with RTK and Fugro Marinestar™ capabilities. We are introducing three additional GNSS receiver variants, broadening the range of positioning solutions available to our customers. Each variant is designed to cater to specific regional and application-based requirements while ensuring core benefits such as: Triple-band RTK support for real-time high-accuracy positioning and post-processing precision. Full compatibility with major GNSS constellations, including GPS, GALILEO, GLONASS, BEIDOU, and QZSS.

www.sbg-systems.com

Modular Ethernet Switch Module

Kontron (Munich, Germany) introduces the KSwitch M20, a modular, non-blocking and fully-managed L2/L3 1/2.5/5/10 Gigabit Ethernet switch module with Precision Time Protocol that offers a comprehensive and versatile feature set for integrating Ethernet switching functions into customized baseboard designs. The KSwitch M20 is the ideal solution for all types of high performance Ethernet switching, whether for military, industrial or avionics applications. The IEEE1588v2 functions enable precise timing synchronization and 'packet time stamping' for time-critical applications. The KSwitch M20 module also supports intelligent Power-over-Ethernet devices with integrated firmware.

www.kontron.com

Edge AI Servers

Supermicro, Inc. (San Jose, CA) is introducing a wide range of new systems which are fully optimized for edge and embedded workloads. Several of these new compact servers, which are based on the latest Intel Xeon 6 SoC processor family empower businesses to optimize real-time AI inferencing and enable smarter applications across many key industries. Supermicro's new SYS-112D series systems are designed to run high-performance Edge AI solutions and feature the recently launched Intel Xeon 6 SoC with P-cores. These servers feature increased performance, improved performance per watt, and higher memory bandwidth compared to previous generations of systems. In addition, the new servers include AI acceleration, Intel® QuickAssist Technology with wireless protocols, Intel vRAN Boost Technology, Intel® Data Streaming Accelerator, and more.

www.supermicro.com

SSD for AI Applications

Kioxia Corporation (Tokyo, Japan) announced the development of its new KIOXIA LC9 Series 122.88 terabyte (TB) NVMe™ SSD in a 2.5-inch form factor – the first SSD built with the company's BiCS FLASH™ generation 8 3D flash memory technology 2 terabit (Tb) QLC die. The KIOXIA LC9 Series, which is under development, will be showcased at various upcoming conferences from this month. Designed for generative AI applications, the new enterprise-class KIOXIA drive is built for high capacity and provides a PCIe® 5.0 interface with dual-port capability for fault tolerance or connectivity to multiple compute systems. These high-capacity QLC-based SSDs are suitable for deploying in hybrid cloud and multi-cloud systems. High-capacity SSDs feed training and inference data to AI server systems via these cloud configurations.

www.kioxia.com

Ultra-High Power Laser Sensor

MKS Instruments, Inc. (Andover, MA) has announced the Ophir® 70K-W Ultra-High Power Laser Sensor, an efficient solution for measuring ultra-high power levels up to 70 kW with high accuracy and dependable performance. This water-cooled, calorimetric sensor measures powers from 2 kW to 70 kW across the spectral range of 900 – 1,100 nm and 10.6 µm. The lightweight design and multiple interfaces – including Ethernet and RS232 – for communication, analog output, and real-time laser power monitoring output, allow easy integration into various industrial and defense applications, such as high-power fiber laser development and testing, industrial cutting, and directed energy systems. Enhanced safety is achieved through a built-in interlock output and exceptionally low back reflection of <0.5 percent, a critical feature for high-power environments.

www.mks.com

Time Frequency Converter

Connor-Winfield's (Aurora, IL) EH320-TFC-CC-DK1 Series represents a fresh approach to precision timing offering synchronized multiple output clocks in a single 22x25mm module. This highly integrated module combines an NPLL system with an APLL system that converts an incoming 1PPS signal to multiple phase locked clock outputs including a phase locked 1PPS 3.3V LVCMOS output. The onboard OCXO is internally and dynamically calibrated offering a free run or holdover stability of < 1 ppb over the full operating temperature range. Phase locked frequencies are preset at the factory, but a wide variety of output frequency combinations from 152 Hz to 730MHz are available on request.

www.conwin.com

RF Multifunction CEMA Platform

Allen-Vanguard (Gloucestershire, UK) a company specializing in customized solutions and enabling technology for Radio Frequency (RF) spectrum monitoring and RF defeat of Unmanned Air Systems (UAS) and Radio Controlled Improvised Explosive Device (RCIED) threats, is launching its next-generation core technology at IDEX 2025. As modern battlefield threats evolve, Allen-Vanguard is responding by launching the cornerstone of their latest RF multi-function Cyber Electromagnetic Activities (CEMA) platform. This new technology enables direct RF sampling, without the use of tuners, across the entire RF spectrum used by UAS and RCIED devices. Allen-Vanguard has engaged best-in-class experts to collaborate on this exciting new project which enables this new more powerful software-defined radio (SDR) platform to form the core of their new products and help dominate the EW space.

www.allenvanguard.com

Thin Film Band Pass Filters

KYOCERA AVX (Fountain Inn, SC) released two new series of compact, thin-film band-pass filters engineered to deliver excellent RF performance in a wide range of high-power applications with crowded PCBs. Designed to satisfy cross-market customer demand for small, high-power band-pass filters, the new BP1206 and BP2816 Series band-pass filters leverage the company's proven, multilayer integrated thin-film (ITF) technology to deliver highly repeatable and reliable RF performance with low insertion loss, steep attenuation, sharp roll-off, low-noise, and high temperature stability. Both series also enable the quick and easy adjustment of RF parameters and feature ruggedly constructed compact, low-profile cases equipped with lead-free, solder-coated-nickel land grid array (LGA) terminations and compatible with automated assembly processes, including reflow, wave, and vapor phase soldering.

www.kyocera-avx.com

100Gb Development Platform

LCR Embedded Systems (Jeffersonville, PA) has released the next generation of its popular DK3 VPX Development Platform. The new DK3HS-4 is 4-slot system that supports 100Gb data rates (25Gb per lane) and is currently available for order. The new development platform is more compact and lighter weight than other DK3 models, but just as cost-effective. It is ideal for test and integration of new and emerging 3U VPX, OpenVPX and SOSA aligned plug in cards in systems with lower slot counts. The DK3HS-4 backplane supports high speed 100GBASE-KR4 and PCIe Gen 4/Gen 5 protocols widely used in these open standards-based applications, which fall under the MOSA initiative mandated by the Department of Defense (DoD).

www.lcrembeddedsystems.com

MANET Power Control

Silvus Technologies, Inc. (Los Angeles, CA) launched MANET Power Control (MAN-PC), a battle-tested solution proven by U.S. military users to minimize RF detection while maintaining robust network connectivity. To mark the official launch and its proven effectiveness, Silvus is offering a limited time 50 percent off discount on MAN-PC software licenses for qualified customers. A core Low Probability of Detection (LPD) feature within Silvus' Spectrum Dominance suite of LPI/LPD, and AntiJamming (AJ) capabilities, MAN-PC dynamically adjusts the transmit power of StreamCaster® MANET radios, ensuring reliable mesh network connectivity while significantly reducing RF emissions.

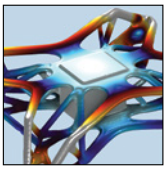
www.silvustechnologies.com

Deployable SATCOM System

Orbit Communication Systems Ltd. (Tel Aviv, Israel), has launched the MPT30Ka Deployable SATCOM System, a cutting-edge Multi-Purpose satellite communication terminal (MPT) designed for rapid deployment in the field. Based on the battle-proven MPT30 platform, this innovative system ensures uninterrupted and secure connectivity for military forces operating in dynamic and complex environments. The MPT30Ka Deployable system is designed as man-portable for an easy field deployment of a SATCOM terminal featuring a roll-on/roll-off capability. This capability provides military forces with the flexibility to establish a high-performance SATCOM link in minutes, ensuring real-time data transmission, secure voice communications, and live video streaming even in GPS-denied environments.

www.orbit-cs.com

Product Spotlight



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COMSOL, Inc.

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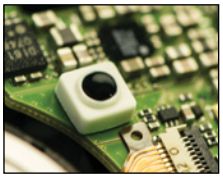
Featuring aluminum, stainless steel, and composite shell configurations, the Tri-Start 38999 Series III TV connector ensures reliable connectivity for general duty use and severe environmental applications. Visit connecticc.com to discover Amphenol high-reliability connectors for military-aerospace and commercial use. https://bit.ly/4jMMgVQ

Interstate Connecting Components (ICC)



FLAME RETARDANT EPOXY

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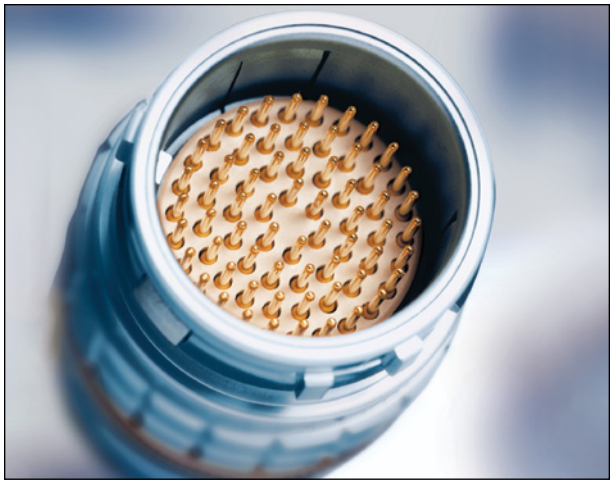
About Our Company

With over 75 years of innovation, LEMO® is a global leader in the design and manufacture of high-performance Push-Pull interconnect solutions. Our connectors are trusted across aerospace, defense, unmanned systems, robotics, and other high-reliability sectors where precision and durability are essential.

LEMO products are built to perform in the harshest environments—from rugged avionics and autonomous ground vehicles to spaceflight systems and tactical communications. Our solutions offer superior EMI shielding, environmental sealing, and compact modular design, helping engineers meet stringent SWaP-C requirements.

With over 90,000 connector combinations, and complete custom design and cable assembly services through our North American partner NORTHWIRE®, we deliver tailored interconnect solutions that meet the most demanding application needs. LEMO serves over 100,000 customers in 80+ countries through its global network of engineering, manufacturing, and support teams.



Target Markets

LEMO supports aerospace, defense, robotics, and unmanned systems engineers with compact, high-reliability connectors for mission-critical applications in extreme environments.

Products/Services Offered

LEMO offers a comprehensive range of rugged, high-performance interconnect solutions designed for the most demanding environments across aerospace, defense, and autonomous systems. Our connectors support data, power, signal, fiber optic, fluidic, and hybrid configurations, giving engineers complete flexibility for system integration.

Our Push-Pull latching mechanism, IP68 sealing, and 360° EMI shielding ensure secure, reliable performance in mission-critical applications – from UxV payloads and vehicle control systems to satellite interfaces and military-grade communications. Every product is built under strict quality control and traceability, meeting the high standards expected across the aerospace, defense, and advanced technology sectors.

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maxon develops and builds high precision electric drive systems that are among the best in the world. Specialists in combining electric motors, gears and DC motor controls into high-precision, intelligent drive systems that can be custom-made to fit the specific needs of customer applications. maxon helps provide innovative solutions at competitive prices for numerous applications in various markets.

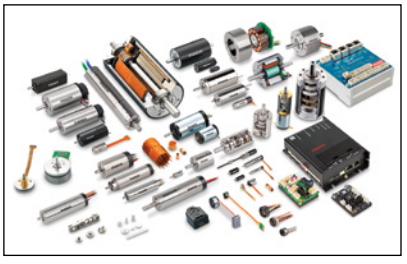
Target Markets

Medical, industrial automation, aerospace, and e-Mobility

Products/Services Offered

Offering solutions that fit your customized needs

maxon's line of products include DC brushed and brushless motors, gearheads, encoders and controllers – these products are easily combined into complete mechatronic drive systems. As a global leader in the design, manufacturing, and engineering services of high precision drive systems, maxon works closely with you to develop innovative product solutions that precisely meet the unique operating parameters of your individual system in your industry. But, did you know that we also offer contract manufacturing services? Consider partnering with us on your next project. We have the experience and industry-specific solutions that will get your product to market faster.



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About Our Company

Specialty Coating Systems is a leader in Parylene, liquid, plasma, ALD and multilayer coating services and technologies with more than 50 years of experience and 21 worldwide locations, including 9 in the Americas, 5 in Europe and 7 in Asia.

Target Markets

Aerospace, defense, electronics, automotive, consumer electronics and medical device

Products/Services Offered

SCS is a direct descendant of the companies that originally developed Parylene and employs some of the world's foremost coating specialists, highly-experienced sales engineers and expert manufacturing personnel. SCS combines its worldwide resources and expertise to provide customers with high-quality coating services and materials that enable their applications to succeed.

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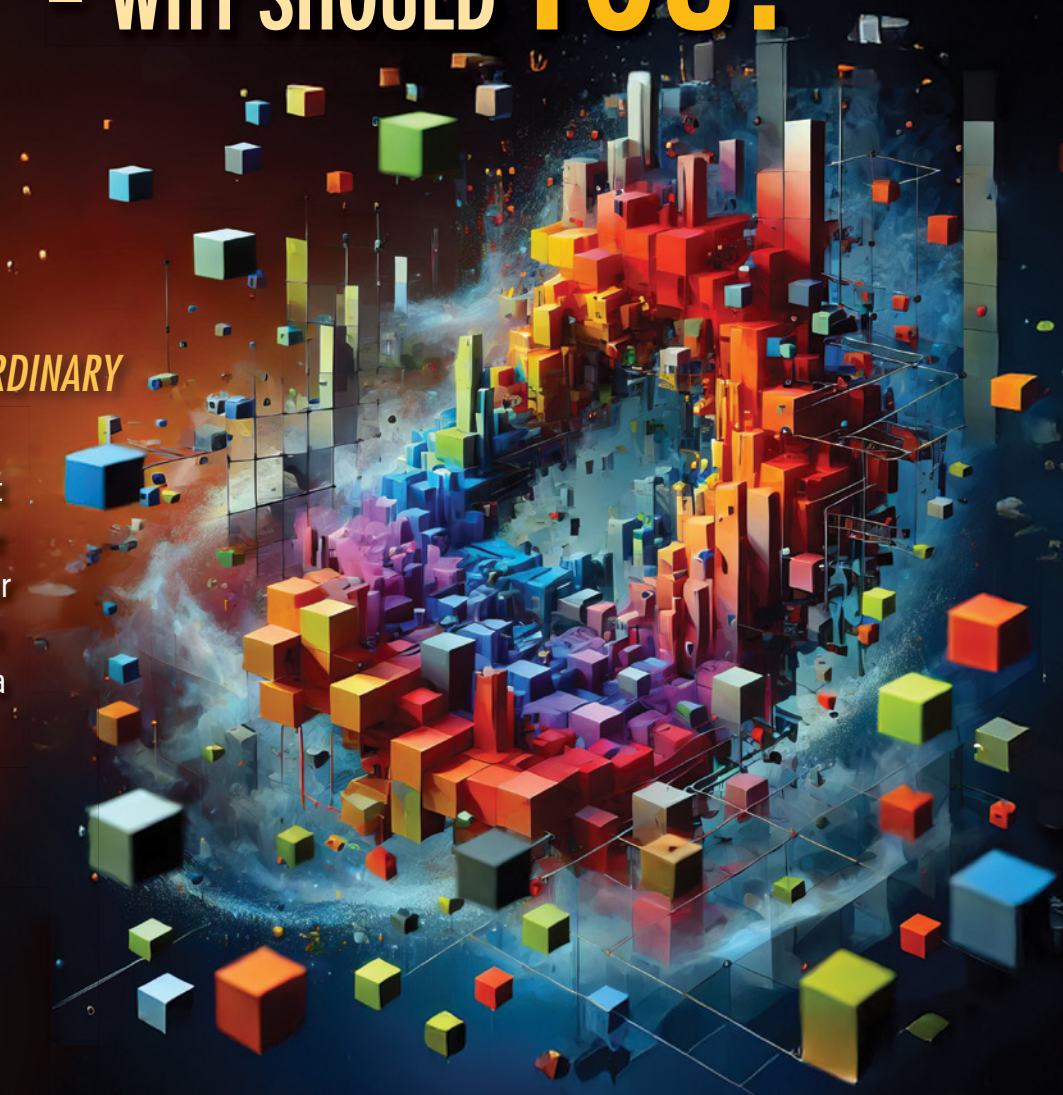

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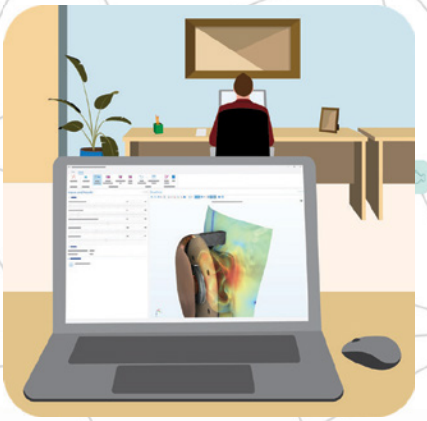

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